Total Surgical Management

MODERN SURGICAL MONOGRAPHS 1

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Total Surgical Management

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Preface

THIS IS A BOOK ABOUT TREATMENT Important as are various para-therapeutic disciplines, the point is finally reached at which the surgeon must treat the specific ailment of the patient before him And the purpose of this volume is to tell about such treatment Treatment in surgery encompasses a great deal—diagnosis, specific preoperative and transoperative measures, and postoperative care Therefore, the title Total Surgical Management has been selected for this volume to achieve a comprehensive designation most suitable to convey the range of the material Much of the material concerns information that is usually passed down by word of mouth, methods and procedures and viewpoints that are the essence of surgical practice but which are not often published It was felt that these things deserved re emphasis in print

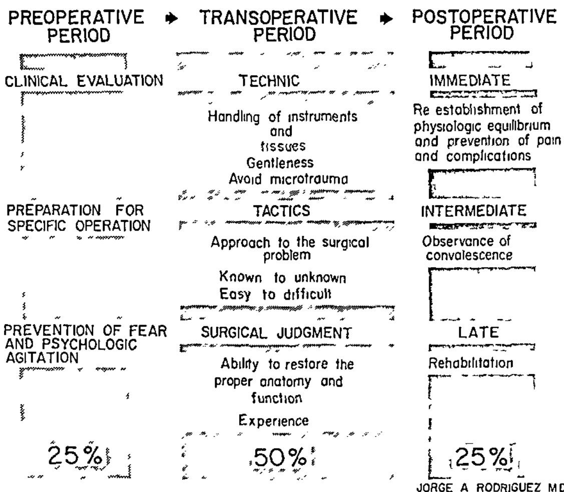
The flow of patient material through a surgical service might be compared to flow from an artery, through the multiple arteriolar and capillary pathways, and out through the common venous channel At the arterial end, all patients must have a common, basic general evaluation Beyond this their hospital requirements and experiences rapidly diverge through special preoperative measures to the widest possible differences during the highly specific operative procedures Thereafter, special postoperative measures are required, converging once again into routine care and preparation for discharge

As may be seen in the diagram, the operation remains the central act in total surgical management, and the importance of a competent technical performance in over all success is paramount At operation the surgeon commits himself and his patients to success or failure, and the nature of this definite act of commission sets surgery apart Here the value of technical proficiency can be either negated or extended by the quality of the surgical knowledge and judgement employed

pulmonary cardio renal function and other essential physiologic activities Chapters 3 through 8 deal with general problems that include fluid therapy and nutrition, blood replacement and the management of shock, abnormal bleeding (coagulation defects), the wound and its management, preoperative and postoperative orders, and trauma and burn management In Chapters 9 through 18 specific operations are taken up, using procedures which serve as prototypes for specific anatomic and physiologic areas of the body Operations on the head and neck include parotidectomy, hemimandibulectomy with radical neck dissection and thyroidectomy, on the thoracic wall, radical mastectomy and thoracoplasty, for intrathoracic procedures, pulmonary resection, general cardiac measures, and esophageal resection, then operations on arteries and veins, for the abdomen, gastric resection, procedures on the liver and biliary tract, splenectomy, operations on small and large bowel, the adrenals and certain hernias Particular emphasis is accorded the diagnosis and management of the acute abdomen Hemorrhoidectomy and other proctologic procedures are discussed In Chapter 19 a few guides for the preoperative and postoperative care of infants are given, and in Chapter 20 considerations of special importance in neuro surgery, urology and gynecology are examined Some points in the safe use of anesthesia are taken up in Chapter 21 In Chapter 22 the problems attendant upon the trip to the operating room are outlined, and in Chapter 24 the actual mechanics of evening rounds on both preoperative and postoperative patients are reviewed

Throughout, specific diagnostic and therapeutic programs are detailed, and particular attention is devoted to the actual management of surgical complications

For Whom the Book Is Intended The volume has been written primarily for the general surgical practitioner In addition, however, it is felt that it will be of essentially equal value to senior medical students, interns and surgical residents In other words, the aim has been to detail points in everyday surgical practice For if the "practical" material taught the advanced medical student is not that which we as practitioners use, then our student teaching should be revised Actually, of course, the difference between the senior medical student's information and that of the practitioner is largely one of quantity—though of course that of the practitioner has also been leavened by experience



Nonetheless substantial segments of surgical success derive also from effective preoperative and postoperative care, and it is especially the preoperative and postoperative problems and complications that are stressed here

Plan of Organization First, general measures of preoperative and postoperative care are dealt with, next specific operations, and finally more general postoperative problems Chapter 1 begins with the initial interview with the patient, emphasizing the importance and the technic of getting to know the individual, the history and physical examination the value of simple sketches, routine laboratory studies, prognostic discussions with the patient and his family and the value of qualified legal counsel immediately upon threat of malpractice litigation Chapter 2 takes up the "volume of operability," including the importance and evaluation of biologic age,

To Julian Johnson and
Jonathan E Rhoads

Acknowledgements A particular pleasure in writing this volume has been that of setting down the more or less standard practices which we employ on our surgical service In the course of doing this I have continuously re examined with our resident staff the effectiveness of the methods presented Dr William A Neely, formerly Chief Resident and now Assistant Professor of Surgery, kindly read the volume in proof Miss Mary Ruth Clayton, Miss Betty Anne Crocker, Mrs Connie J Jarratt, and Miss Virginia B Ward assisted with the manuscript Lastly, special appreciation is expressed to the editors and staff of Grune and Stratton, Inc

JAMES D HARDY, M D

1 *General Approach to the Patient*

THE SUCCESSFUL PRACTICE of surgery combines the total preparation of the patient with the total capacities of the individual surgeon This fusion begins with the first examination of the patient

THE INITIAL INTERVIEW

The initial interview with the patient and the first subsequent meetings usually establish the plane of the eventual patient-physician relationship Thus, the physician enters the patient's room with all faculties alert to sense the general mood of the individual, his reaction to the hospital surroundings and to his pathologic condition and the approximate degree of physiologic depletion The experienced examiner is keenly aware that his approach must be quickly and subtly adjusted to the needs of the patient as he finds him For example, in a relatively simple situation, such as that of the patient admitted for routine elective herniorrhaphy, one short interview may serve both to gain the essential information and to "get to know" the individual reasonably well This is because the patient is usually not very anxious He knows his prognosis is good and he talks freely In contrast, the patient who needs exploratory laparotomy for suspected carcinoma of the ampulla of Vater may require much more of the surgeon's time First, the diagnosis of obstructive or "surgical" jaundice may be in doubt—and hepatitis is a definite contraindication to major surgery Second, the patient has usually been ill for some time, and his physician often has not been able to be specific regarding diagnosis and treatment The patient has long since interpreted the jaundice, weight loss, anorexia and lack of effective therapy as ominous phenomena, and he perhaps wonders silently whether or not he has a tumor about which the doctors have not told him Such a patient cannot be adequately known during an initial brief interview Time, patience, perception and sympathy are all required to allow this individual to develop full confidence in his surgeon Frequently the confidence of the patient is strengthened when he observes the confidence which nurses, house officers, friends and

the patient may ramble aimlessly unless prompted and reoriented from time to time

As the history taking proceeds the patient will in most instances gradually relax and begin to talk more and more freely In this respect, the mechanics of taking the history and performing the ensuing physical examination afford both the ill at-ease patient and the surgeon a form of purposeful and somewhat objective activity as they are getting emotionally acquainted with and adjusted to each other Again, the intermeshing of personalities is a singularly desirable feature which colors all subsequent phases of management

Any specific complaints which the patient has must not be ignored, even if they are "obviously" irrelevant If the patient considers them important, they are important They must be listened to attentively or else his confidence will be impaired

Finally, it has been noted that the examiner must adjust his mood to that of the patient If levity is risked, it is offered with the full realization that most patients approach a major operation in a serious frame of mind In general it is safer to adopt a cordial but serious attitude Cheerful optimism is always welcomed by the anxious subject

THE PHYSICAL EXAMINATION

One hallmark of the competent physician is the care, perception and accuracy with which he performs and records the clinical examination Moreover, the patient is quick to appreciate that a complete examination has been carried out Few other facets of patient care are so easily attainable and so often ignored as is the orderly head to toe physical examination Since many individuals have never had a systematic examination, the subject is almost invariably favorably impressed Frequently omitted is the meticulous examination of the oropharynx and breasts, as well as rectal and pelvic examinations Patients also expect the blood pressure to be taken ("He didn't even take my blood pressure")

Naturally special attention will be directed to the areas of the body which have been mentioned by the patient during the history Simple sketches enhance the value of the record (FIG 1)

ROUTINE LABORATORY STUDIES

The serology, blood count and urinalysis should be done routinely as screening procedures The chest x ray belongs almost in the same

relatives have in the surgeon Therefore, the *effective psychologic* preparation of the patient must be extended to every person with whom he will have either direct or indirect contact, and experienced surgeons take full advantage of these relationships Discouraging information from friends, nurses or even other patients has caused many an individual to refuse operation

As implied, it is not always advisable to attempt to accomplish everything in one session, especially if there is no emergency At each of a series of visits one can learn to know his worried or ill-at ease patient just a little bit better, until mutual trust and respect have been developed

These relationships are intangibles, to be sure, but they are a part of the essence of surgical experience and skill To be appreciated, the doctor-patient relationship must be felt, to be felt, it must be earned

THE HISTORY ITSELF

It is very important to approach the patient with an open mind One is well advised, in most instances, to decline advance information regarding other physicians' opinions and findings These are available in the record, and they can be consulted subsequent to a completely independent and unbiased appraisal of the case

The actual formal clinical evaluation begins with the elicitation of an accurate and sufficiently detailed history to permit proper analysis Every item of possibly useful information regarding the presenting complaint will have been woven into a fabric which one hopes will provide a mosaic of the disease The presenting complaints the review of systems the past medical history (is the probable intestinal obstruction due to old postoperative adhesions?), the family history (the "bleeder s grandfather was a hemophiliac) and the social history (hemoptysis in the heavy smoker of hematemesis in the heavy drinker) are all needed for a comprehensive evaluation of the patient

As the taking of the patient's history proceeds, the experienced examiner will keep in mind and methodically seek to eliminate or include the various diagnostic possibilities which the symptoms suggest While it is preferable to allow the subject to tell his story in his own way, it is not always practicable The examiner may wish to break in to confirm or further to develop specific complaints Too,

TABLE 1—*Professional Communication Obligations*

1. TO PATIENT AND HIS FAMILY The patient and appropriate relatives must be briefed in advance of operation if serious misunderstandings and instances of distrust are not to arise A free and frank preoperative discussion is exceedingly helpful in preparing all concerned for whatever results may be achieved by the surgery
2. TO NURSES The orders should be clearly and precisely written at a time early enough in advance of surgery, and they should be brought immediately to the attention of the nursing staff in accordance with established procedure in the hospital concerned It is also helpful to indicate what operation is contemplated e g *Preoperative Orders* (*For Cholecystectomy*)
3. TO IMMEDIATE COLLEAGUES The individual member of the surgical team should call attention in the progress notes and otherwise inform his associates as to points of particular interest and importance which may arise in connection with the case (e g, a friction rub, calf tenderness low plasma chloride level or a 'space problem' on the chest film)
4. TO REFERRING PHYSICIAN Even though the patient may be in a hospital fifty miles away, the family physician is often expected by the family to be informed at all times He may plan to attend the operation, often at the insistence of the relatives and certainly he must care for the patient on discharge Thus, he should be called at some time prior to surgery the 'work up' findings are then described and the date for surgery given A call following surgery (or less effective a note) will let the doctor know immediately what was found and done and what postoperative measures will probably be required when the patient comes home

LEGAL PROBLEMS

Virtually every surgeon is apt to be sued or threatened with a law suit at some time in his career Naturally each hopes that he will escape this experience, but he must nevertheless be prepared for suit in every case that he treats

The best protection against law suits resides in detailed records Permission for operation should be properly signed It is well to remember that no operation can be guaranteed and that criticism of previous treatment by others may prompt a patient to file claims when no such thought had been entertained before Most important, at the first hint of possible suit one's attorney and liability insurance carrier should be notified, and all records should be carefully put into safekeeping

Finally, the physician should take the time to learn something of legal procedure In doing so he will come to realize that the legal profession has its own set of rules and goals These differ markedly from those of the medical profession, and the immediate recourse to

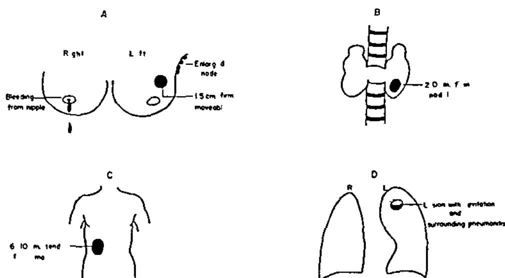


Fig 1—A simple diagram vastly facilitates visualization by others of the pathology the operation best suited to the patient and the patient best suited to the operation

category In patients above the age of 50 the N P N and fasting blood sugar levels and an electrocardiogram constitute sound preoperative measures Special studies having to do with particular systems will be presented in various subsequent chapters

DISCUSSIONS WITH PATIENT AND FAMILY

It is a good practice, after completing the initial evaluation of the case to sit down with the patient and responsible members of his family and discuss the probable diagnosis, whether or not an operation is indicated, what can reasonably be hoped for immediately and what the ultimate outcome may be Of course, a "completely hopeless" prognosis may be mitigated in the presence of the patient, but the family should know the stark truth, insofar as it can be perceived It is also our practice to conclude the discussion with an offer to answer any questions which the patient or his family may have If questions concerning the fee are asked, they are answered promptly

Such an approach usually convinces the patient that the operation is necessary, that all possible contingencies are being anticipated and prepared for, and that his life is being entrusted to the care of a competent surgeon (TABLE 1)

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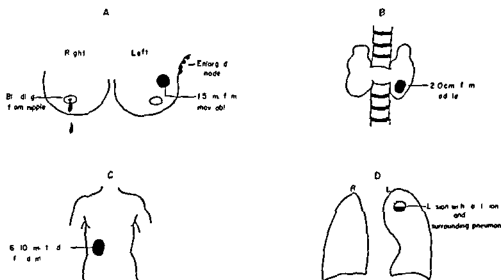


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2 *The Volume of Operability*

WISDOM CONCERNING what surgery the individual patient can withstand is usually referred to as "surgical judgment" It is what is utilized in the 'selection of patients' for a particular operation Not only must the patient be able to survive the procedure in question but there must be a good chance that he will be benefited significantly The ability to estimate accurately the clinical probabilities in a given situation is derived in large measure from previous experience Nevertheless there are certain guides that anyone can methodically follow with reasonable success These will now be reviewed (FIG 2)

Age The terms *chronologic age* and *biologic age* have been developed to denote the actual age in years as contrasted with the relative physiologic youth of the individual Many patients are "old" at 60, whereas others are in excellent physiologic condition at 75 or more Therefore, both chronologic and biologic age are useful considerations in estimating the operative risk

While one does not hesitate to perform surgery on an elderly person when the pathologic condition justifies the risk it would be inaccurate to insist that youth does not reduce the hazards of most major operations Put simply more patients of 20 will survive a given operation than will patients of 70 This is because both the immediate mortality and the postoperative complications increase as old age approaches Cardiac decompensation cerebrovascular accidents pulmonary insufficiency and renal failure represent complications which occur more frequently with advancing age In planning surgery in older persons it is important to estimate the total physiologic reserves and then to adjust the magnitude of the surgery to the volume of operability

Cardiovascular System It is a good policy to request an electrocardiogram in all patients over 50 Whereas valvular and hypertensive heart disease can usually be detected by the physical examination asymptomatic coronary and myocardial disease may be detected only with the ECG, if at all Again, if evidence of serious

competent legal advice in all threatened litigation is the only safe procedure for most physicians to consider

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sion and ascites must be detected and removed, in most cases, to improve pulmonary ventilation Blood transfusion during surgery should be employed with particular caution Frequent tracheal aspiration, sufficient atropine and, if needed, positive pressure oxygen therapy may be used to reduce fluid in the tracheobronchial tree if pulmonary edema should develop Venous tourniquets and aminophylline may prove beneficial in the further therapy of this condition Chlorpromazine has been used to reduce the central blood volume in such patients

Pulmonary Reserve One of the commonest causes of diminished pulmonary function is that produced by "senile" emphysema However, a great many pathologic conditions can significantly impair pulmonary reserve Since adequate lung function is essential to surgical success, the appropriate clinical and laboratory studies should be employed in any patient who gives evidence of pulmonary insufficiency or disability These are considered in some detail in CHAPTER 11, but the patient with significant bilateral pleural effusion obviously constitutes a poor anesthetic risk

Patients with advanced pulmonary disease are often better managed with a local or spinal anesthetic Where general anesthesia must be used in the emphysematous subject, the pulmonary ventilation should be continuously effective in the postoperative period, the inevitable quantitative and perhaps qualitative alterations in the bronchial secretions are a special hazard in these subjects Breathing exercises, bronchodilators and humidifiers may enhance the efficiency of respiration and prevent pulmonary insufficiency for CO_2 elimination and oxygen uptake

Few problems are more distressing than respiratory insufficiency that has been precipitated by an elective operation Patients with borderline lung function are poor operative risks

Renal Function Elective major operations are rarely performed in patients who are known to be in renal failure so serious is this pathologic state Unfortunately the "high normal" N P N level reported preoperatively may have reflected marginal renal compensation and the additional stress of anesthesia operation may result in frank renal insufficiency Where postoperative renal insufficiency develops due to the effect of hypotension on previously normal kidneys recovery may continue until almost normal function has been restored In contrast the most that can be hoped for in the patient

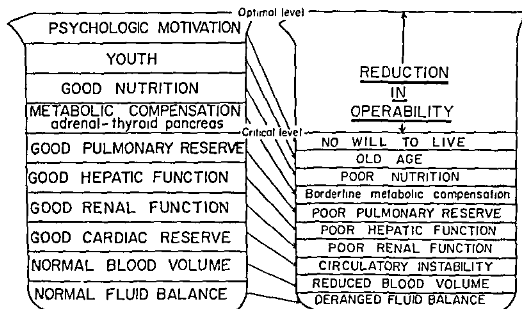


FIG 2—*The Volume of Operability* Many factors must be considered in selecting the operation best suited to the patient and the patient best suited to the operation

myocardial disease is disclosed, an elective operation may be abandoned or an essential procedure modified

As a rule digitalization can be delayed until it is obviously indicated Digitalis preparations now available permit very rapid achievement of digitalis effects Lanatoside C is a useful drug in this respect

Patients with valvular heart disease, especially those with moderately severe mitral regurgitation, may tolerate surgery surprisingly well In contrast, patients with coronary disease, angina associated with aortic regurgitation or stenosis, or mitral stenosis with its risk of pulmonary edema constitute serious operative risks, and elective surgery may be contraindicated Patients with severe hypertension are particularly prone to develop myocardial infarction, acute pulmonary edema hemiplegia or renal failure Any fall in blood pressure during anesthesia perhaps due to spinal block of the sympathetics to the lower half of the body, is especially hazardous in the previously hypertensive subject

In brief, the proper procedures must be employed in the cardiac patient to avoid shock due to faltering of the "pump" In addition to digitalization where indicated such measures include the elimination of edema fluid with diuretics and salt restriction Pleural effu-

Various other factors which must be taken into account in assessing the operative risk are shown in FIGURE 2 These and many other even less sharply defined factors such as for example, the patient's general appearance to the experienced observer must be weighed in evaluating the total physiologic reserves of the preoperative subject

THE FUNCTIONAL RESERVE OF INDIVIDUAL ORGANS

One does not always appreciate the remarkable degree to which reserve function is available to the normal youthful adult This point is emphasized below where the amounts of tissue of different organs that can be sacrificed, with "adequate" residual function, have been indicated

Organ	Total Size or Number	Approximate Minimal Requirement
Lungs	20 segments	5 segments
Small Bowel	22 feet	5 feet
Kidneys	2	<1
Liver	2 principal lobes	<1 lobe
Adrenals	2	<½ of 1
Parathyroids	4	1

Therefore, in the young person whose body tissues are functioning maximally, there is a tremendous margin of safety In contrast in the elderly patient whose cardiac-pulmonary-renal tissues are impaired tissue can be sacrificed with much less freedom To perform a pneumonectomy or a nephrectomy in the person of advanced age is often to risk pulmonary or renal insufficiency

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TABLE 2—*Normal Chemistry Values in Blood and Urine*

Constituent (in Blood or Plasma)	Normal Value	Constituent (in Urine/24 Hrs.)	Normal Value
BUN	8–15 mg %	Ca (on low Ca diet)	0.1–0.3 Gm
Bromsulfalein retention	>5–10% after 45′	Creatinine	0.7–1.8 Gm
Ca	9–11 mg % (5 mEq./L.)		
Cl	97–106 mEq./L.	17 ketosteroids	10 mg. (♀) 15 mg. (♂)
CO_2	25–30 mEq./L.	K	40–65 mEq.
F.B.S.	80–120 mg. %	Na	130–200 mEq.
17-21-Hydroxycorticosteroids	Free 7–15 µg. % Conj. 2–5 µg. %		
K	3.5–5.5 mEq./L.		
Mg	1.5–5.5 mEq./L.		
Na	138–147 mEq./L.		
N.P.N.	25–40 mg. %		
P	3.0–4.5 mg. %		

with chronic renal disease is often merely a return to the precarious balance that existed preoperatively.

Like the routine ECG in patients over 50, the routine preoperative N.P.N. or BUN measurement is an important screening test (TABLE 2). If the specific gravity of the urine is below 1.015 or the N.P.N. elevated, the more elaborate studies such as the urea clearance (for estimating glomerular filtration), the concentration test (for measuring tubular reabsorption) and the P.S.P. test (for measuring tubular mass and excretory capacity) should be performed.

The patient who has marginal renal functional reserve will often require the formation of much more than the normal volume of *urine in order to excrete the approximately 35 Gm.* of solids formed daily by body metabolism.

Nutrition, Water and Salt Reserves and Blood Volume. These factors, all of which are vitally important in influencing the volume of operability, will be separately discussed in future chapters. It is sufficient to state that inadequate nutrition has been shown to impair the function of all organs of the body. Shock quickly follows the marked depletion of water and electrolytes, or the acute depletion of the red cell mass. Moreover, even if the blood pressure should be normal at the start of anesthesia, the vasodilatation which often ensues will too frequently result in abrupt hypotension in the subject whose blood volume is depleted.

TABLE 3—*An Approach to Fluid Therapy*

1 DIAGNOSIS OF FLUID IMBALANCE
(Water and Salt Deficits Acid Base K and Mg)
Clinical signs of dehydration are due largely to extracellular deficit
Electrolyte imbalance is reflected in plasma chemistry values

2 REPLACEMENT OF FLUID DEFICITS
Questions to be decided How much? Of what? How fast?

3 ESTIMATION OF VOLUME REQUIREMENT
Mild Dehydration—4% of body wt
Moderate Dehydration—6% of body wt
Marked Dehydration—8% of body wt
(Give up to 5 liters in first 12 hours, if required)

4 ESTIMATION OF SALT NEED
Rule of Thumb
Normally mEq of Cl (103) plus mEq of CO_2 (27) = 130
If this sum is less than 120 give hyper tonic saline initially (500 cc of 3%)
If this sum is greater than 135 give glucose in water initially
(Recheck plasma CO_2 and Cl frequently until osmolar balance achieved)
Volume Mainstay Isotonic saline or balanced electrolyte solution

5 ACID BASE IMBALANCE
Alkalosis—HCl or NH_4Cl rarely necessary in adults Correct with K and NaCl
Acidosis—Use 1/6 Molar sodium lactate or sodium bicarbonate
Dose—4 cc /Kg body wt elevates CO_2 approximately 1 mEq
Give only one half calculated dose initially

6 POTASSIUM DEFICITS
Diagnosis—Clinical flame photometer ECG
Treatment—Daily K requirement 3-6 Gm KCl May need 12 Gm daily to replace deficit Give as 0 6% KCl I V

7 REPEATED RE EVALUATION OF RESULTS OF THERAPY

TABLE 4—*Fluid R_x Case Study*

PYLORIC OBSTRUCTION Age 52 Wt 132

Physical Exam	Marked dehydration (water loss = 8% body wt —see text)
Lab	Cl—70 mEq /L (Normal 103)
	CO_2 —36 mEq /L (Normal 27)
R_x	Volume Deficit 132 − 2 2 = 60 Kg × 8% = 4800 cc
Salt?	Yes 70 + 36 = 106 mEq (Normal 130)
	Give 500 cc 3% NaCl follow by 0 85% NaCl in glucose
K Deficit?	Likely Later 0 6% KCl I V
Rate	Give the 5 L in 8–12 hr

equals 5 6 liters of water required—the deficit), moderate dehydration 6 per cent, and mild dehydration, 4 per cent

Thus, having estimated that the 70 Kg man who gives clinical evidence of severe dehydration has lost from 5 to 6 liters of body weight as water and needs this volume for replacement, what salts shall the first 5 liters of replacement fluid contain?

The *salt* (*osmolar*) *deficit* is estimated on the basis of *laboratory* data While a liter of isotonic saline is being infused, the laboratory

3 *Fluid Therapy and Nutrition*

FOR MANY SURGEONS the term preoperative and postoperative care is almost synonymous with preoperative and postoperative fluid therapy and nutrition This emphasizes the importance which all now accord the effective replacement of water, salt, protein and caloric deficits, both prior to and following surgery

The purpose here is to outline preoperative and postoperative fluid and nutritional therapy for the depleted subject and for the normal subject coming to an elective operation

REPLACEMENT OF WATER AND SALT DEFICITS

The following orderly series of steps may be used in the diagnosis and treatment of the vast majority of patients who enter the hospital with derangements in water balance In surgical patients the defect on admission is usually one of fluid deficit due to vomiting or diarrhea Both water and electrolytes will have been lost, though the electrolyte depletion may be relatively greater than water depletion often because only salt-free fluid has been ingested during the period of vomiting The elements which must be replaced are most commonly *water, sodium, chloride and potassium*

How, though, does one decide the approximate volume and electrolyte composition of the fluid that must be given in therapy?

Diagnosis of Fluid Imbalance

The *diagnosis* of the degree and the type of fluid imbalance (TABLES 3 AND 4) which has been produced will be made on the basis of both *clinical* and *laboratory* data The degree of dehydration (the *volume deficit* that must be replaced) is estimated largely from the appearance of the patient and the circulatory status Is the tongue dry, the skin turgor diminished the eyeballs soft and sunken, the pulse thready and rapid and the blood pressure approaching a shock level? Is the urine scant and concentrated?

Severe evidence of dehydration reflects a volume of water loss equal to from 8 to 10 per cent of body weight (8 per cent of 70 Kg

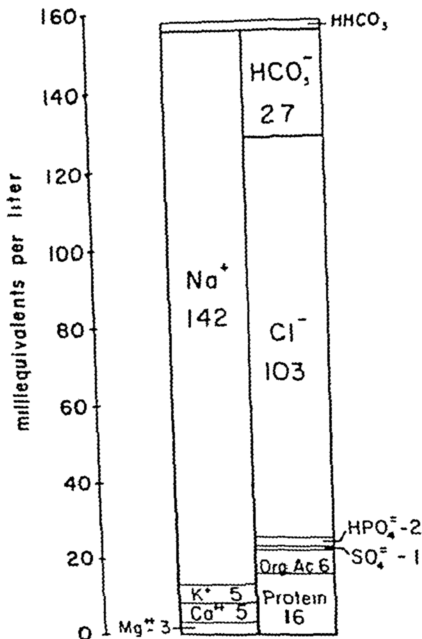


FIG 3—*Plasma Electrolyte Values* An understanding of normal and abnormal plasma electrolyte relationships is essential to intelligent fluid therapy (Redrawn from Gamble J L Chemical Anatomy Physiology and Pathology of Extracellular Fluid Cambridge Mass Harvard University Press 1949)

ing with scintillating scotoma may be precipitated The dose of sixth-molar NH_4Cl is approximately 4 2 cc /Kg of body weight to lower the plasma 'CO_2' 1 mEq /L

Treatment of Metabolic Acidosis For the acidosis of diabetes mellitus or renal dysfunction one may use either sodium bicarbonate

measurements of plasma carbon dioxide combining power ("CO_2") and chloride can be obtained and if available, sodium and potassium levels Normally, the plasma "CO_2" level is about 27 mEq /L, and the chloride level is about 103 mEq /L The sum of these values is 130 mEq /L If the sum is less than 120, relatively more salt than water is required in therapy, if the sum is approximately 130, isotonic saline (5 liters) may be used, if the sum is greater than 135, relatively more water (as glucose solution) than salt will be required Actually, since to infuse sodium chloride solution introduces a physiologic excess of chloride relative to sodium (FIG 3) and will eventually produce acidosis, there is an increasing tendency to use a solution containing one-third sodium bicarbonate (sixth-molar) and two-thirds isotonic sodium chloride for intravenous infusion This of course gives an excess of sodium ion relative to chloride ion in the repair fluid which corresponds to the normal plasma sodium (142 mEq /L) and chloride (103 mEq /L) values

Having estimated the *volume deficit* (5 6 liters) and the *salt deficit* (or excess), one next diagnoses the state of *acid-base balance* This is based on the plasma "CO_2" value plus the clinical appraisal of the patient For example, a high plasma "CO_2" value could reflect either metabolic alkalosis or respiratory acidosis However, the fact that the patient has been vomiting from probable pyloric obstruction, taken together with apparently adequate respiratory function favors the diagnosis of metabolic alkalosis The alkalosis is usually due to a loss of both chloride and potassium, and it is perhaps the commonest type of acid-base imbalance encountered on a surgical service As a rule the metabolic alkalosis does not require the intravenous administration of hydrochloric acid or ammonium chloride As free renal function is restored with the isotonic salt solution, which in itself is acid when compared with plasma, the kidney will retain what is needed to restore acid base balance Moreover, potassium may safely be administered once urine output is re-established, a potassium deficit may either cause or aggravate metabolic alkalosis

Treatment of Metabolic Alkalosis Only when signs of alkalotic tetany develop are special acidifying solutions used Tetany is more apt to develop in the alkalotic infant than the alkalotic adult When hydrochloric acid solution is used it should be given in isotonic saline to avoid pain (due to hypotonicity?) Ammonium chloride solution (sixth molar) must not be given too rapidly, else nausea and vomit-

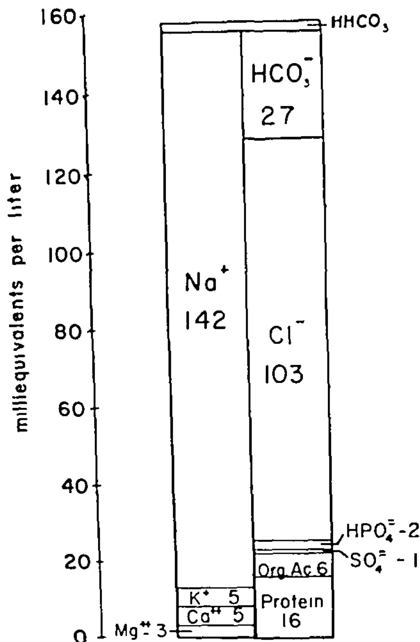


FIG 3—*Plasma Electrolyte Values* An understanding of normal and abnormal plasma electrolyte relationships is essential to intelligent fluid therapy (Redrawn from Gamble J L Chemical Anatomy Physiology and Pathology of Extracellular Fluid Cambridge Mass Harvard University Press 1949)

ing with scintillating scotoma may be precipitated The dose of sixth molar NH_4Cl is approximately 4 2 cc /Kg of body weight to lower the plasma "CO" 1 mEq /L

Treatment of Metabolic Acidosis For the acidosis of diabetes mellitus or renal dysfunction one may use either sodium bicarbonate

or sodium lactate in therapy The dosage of sixth-molar lactate required to *raise* the plasma "CO_2" 1 mEq /L is 4 2 cc /Kg of body weight When using sodium bicarbonate in the treatment of acidosis in adults, we usually infuse 15 Gm in a liter of water and thereafter recheck the plasma "CO_2" level to determine the effect before giving further alkali The effect of a given amount of therapy will vary considerably from one patient to another

Specific ion deficits, particularly those of potassium and calcium, may appear as rehydration proceeds *Potassium deficiency* is reflected in the ECG and in the plasma potassium level as measured with the flame photometer Once effective renal function is restored, 6 Gm of potassium chloride may be given in a liter of saline or glucose solution This represents an 0 6 per cent solution of potassium chloride or 80 mEq of potassium ion The average daily excretion of potassium in the urine is about 50 mEq Thus, to overcome a severe deficit one must give perhaps 12 Gm or more of potassium chloride in divided doses each day It is well to infuse no more than 6 Gm over any given 2 hour period lest hyperkalemia be produced Once the patient is taking food by mouth the potassium deficit usually disappears, in the absence of ACTH or corticosteroid therapy

Calcium deficits are treated with intravenous calcium gluconate or calcium lactate A dose of one or more grams is given and repeated as required As soon as oral intake is feasible, any residual deficit can be treated with a daily intake of 12 Gm of calcium gluconate or lactate in divided doses

Summary Fluid Replacement

The 5 6 liters of fluid estimated to represent the volume deficit of a severely dehydrated 70 Kg adult would be given at variable rates of speed, depending on the clinical circumstances, and it would be given in the form of isotonic sodium chloride solution or isotonic sodium chloride sodium bicarbonate solution (two-thirds NaCl and one-third $NaHCO_3$)

If the patient has small bowel obstruction for which early surgery is required, perhaps only 3 liters would be given in 2 hours, the remainder of the deficit being replaced postoperatively On the other hand, if vomiting has been due to pyloric obstruction which does not require an emergency operation, then a period of 12 hours may be

utilized in infusing the 6 liters (estimated deficit, 5 6 liters) of fluid In addition, during this 12 hours continuing losses would have occurred in the form of gastric suction, urine and insensible loss (sweat and lung vaporization) This deficit must be added to the admission volume deficit, but it can be taken into consideration in planning fluid intake for the second day of hospitalization One does not expect completely to correct in a period of hours the losses that have occurred over a period of days Rather, where time permits, the objective is to improve the general condition of the patient and to restore deranged plasma electrolyte values to normal in an orderly fashion This may require from 48 to 72 hours if severe electrolyte derangement has occurred

One of the more difficult problems in fluid management is that of detecting a volume deficit in the postoperative patient, especially when the urine volume is above normal Unless the plasma sodium, chloride and N P N levels rise, one is forced to rely largely on physical signs of dehydration in diagnosing a relative water deficiency However, the use of scales for weighing a critically ill patient daily will remove much of the guesswork regarding whether or not the patient is being underhydrated or overhydrated Of course, a carefully kept intake-output record is of great assistance, but excessive sweating in the febrile patient confuses the issue

It cannot be too strongly emphasized that successful fluid management entails frequent observation of the patient and repeated measurement of plasma electrolyte values If therapy is not producing the desired results, it must be revised (See also TABLES 5 AND 6)

PREOPERATIVE AND POSTOPERATIVE NUTRITION

Water and salts are essential elements of nutrition, but the term nutrition usually connotes the intake of protein, fat, carbohydrate and vitamins

TABLE 5—*Normal Daily Fluid and Electrolyte Requirements in Adults*

1 Water
   a 1200 cc for urine
   b 1000 cc for insensible loss (skin and lungs)
   c 300 cc in feces
   Total—2 500 cc
2 Sodium chloride—6–8 Gm
3 Potassium chloride—6 Gm (approx 80 mEq of K)

TABLE 6—*Repair Solutions in Fluid Therapy**

1. PURE WATER DEFICIENCY Hyperosmolarity hypertonicity 5% glucose in water
2. WATER AND SALT DEFICIENCY Isoosmolarity 0.85% (8.5 Gm.) NaCl in 5% glucose solution (145 mEq. Na/L and 145 mEq. Cl/L.)
   Hypo-osmolarity 3% NaCl (513 mEq. or mOsm. of Na and 513 mEq. or mOsm. of Cl/L.)
3. EXTRACELLULAR WATER AND SALT DEPLETION IN CHILDREN Solution composed of 2 parts 0.85% NaCl and 1 part M/6 lactate or M/6 $NaHCO_3$. This infusion provides no potassium but a relative excess of chloride is avoided
4. POTASSIUM DEFICIENCY 0.6% (6 Gm.) KCl in 0.45% NaCl (approximately 80 mEq. K/L.) In severe deficiency with adequate renal function one may give 1.2 per cent KCl (12 Gm./L.) provided the patient is carefully and continuously examined and the infusion *does not* exceed a rate of 60 drops/min.
5. ACIDOSIS M/6 sodium lactate solution (16 Gm./L.) or M/6 sodium bicarbonate (14 Gm./L.)
   Alkalosis Adults 2% ammonium chloride solution (20 Gm. NH_4Cl/L.) Hydrochloric acid in saline may also be used
   Children M/6 ammonium chloride solution (9 Gm. NH_4Cl or approximately 167 mEq. Cl/L.)

* From Hardy, J. D.: Fluid Therapy. Philadelphia, Lea and Febiger, 1954.

Clinical Value of Adequate Nutrition

Numerous studies have documented the fact that all organs are adversely affected by one or more forms of starvation; starvation is a major feature of many illnesses of special interest to surgeons. The nervous system functions abnormally, both as to mood and motor activity, when severe caloric and/or thiamine deficiency exists. Pulmonary infections commonly reflect lowered tissue resistance in starved populations. Anemia, hypoproteinemia, diminished heart size and less efficient vascular (postural) reflexes hinder normal circulatory function in malnourished subjects. Hepatic cirrhosis follows certain forms of protein depletion. Abnormal gut motility and absorption may reflect vitamin deficiencies. Many endocrine organs—including the pituitary, thyroid, adrenals and testes—exhibit hypofunction in starved individuals.

These facts, together with the increased operative morbidity and mortality frequently observed in starved patients, afford an adequate basis for diligent efforts to improve the nutritional status of patients who are depleted. And the word diligent is chosen deliberately, for few therapeutic endeavors are less dramatic and more time-consuming than nutritional rehabilitation. Nevertheless, it is only through persistent effort day after day that a nutritional intake can be achieved which truly begins to restore normal mass and activity

in the various organs and depots of the body That is, whereas corrective fluid therapy for severe electrolyte imbalance may require only several days, restorative nutrition in severe protein-vitamin-caloric depletion requires weeks and even months Fortunately, if by aggressive realimentation one can reverse weight decline and cause the patient to gain even a few pounds, perhaps in a period of from a week to 10 days, then even this improvement in nutritional status may improve the operative risk remarkably

Basic Nutritional Requirements

It is useful to have in mind what the minimal requirements of the adult patient might be if he remained quietly in bed and free from fever or unusual losses (such as by enteric fistula or open wound) The caloric requirement ranges from 25 to 30 calories/Kg of body weight, and the protein requirement is approximately 1 to 1 5 Gm /Kg of body weight However, the very fat person has a relatively low lean body mass, expressed as a percentage of body weight, since fat is less active metabolically than is muscle, the fat person would require relatively fewer calories and grams of protein per kilogram than would a lean muscular subject of the same body weight

Again, the values given are minimal values Fever, increased metabolism from hormonal alterations, exercise, and external losses as from wounds or fistulas will increase the nutritive requirements Therefore, the therapeutic aim is not to calculate precisely what the requirements may be but to make certain that the requirements in the individual under treatment are actually exceeded by the protein, caloric and vitamin intake Accordingly, an intake of from 3,000 to 6,000 calories and from 150 to 200 Gm of protein is usually striven for A multivitamin compound is employed which provides in excess of probable requirements of the vitamins contained therein Above all, one must make certain that the diet prescribed is actually consumed by the patient, and that substantial amounts of the ingested nutrients are not lost because of diarrhea For accurate data in the critically ill patient, the dietitian should be asked to estimate the food values of materials in the prescribed diet that are not eaten by the patient, these values are then subtracted from the total diet to estimate the protein and caloric values of the food that was ingested

The requirements for different food elements are considered in de-

tail in "Therapeutic Nutrition," Publication 234 of the National Academy of Science, National Research Council, Washington 25, D C

Nutritive Value of Different Foodstuffs

Therapeutic alimentation, to be effective, must take into account the caloric and protein values of different foodstuffs, which follow

Substance	Cal /gram
Carbohydrate	4
Protein	4
Fat	9
Alcohol	7

Thus, intravenous glucose, fructose and protein hydrolysate all afford 4 calories/Gm Since most diet trays are made up of solid foods, often of a complex nature, it is necessary to have reference tables which may be consulted in computing caloric, fat, carbohydrate and protein values Valuable data of this type have been published in "Composition of Foods," (Raw, Processed, Prepared), U S Department of Agriculture Handbook No 8

The Therapeutic Hospital Diet

The patient who is most in need of therapeutic alimentation is likely to be the one whose appetite is the most capricious For this reason it is highly desirable that food of proper composition be served as attractively as possible Details are to be dwelt upon (1) The food should be hot and served promptly, (2) the coffee and soup should not be spilled on the tray and these should also be hot, (3) the personnel serving the food should assist by being prompt, quiet, courteous and co operative, (4) patients who cannot easily feed themselves must be assisted, and (5) pleasing colors with perhaps a small flower may enhance the patient's appetite (FIG 4)

The aim is usually to achieve the maximum ingestion of calories and protein This requires of course, that the patient consume the diet It has been fully accepted that concessions must often be made to ensure that the food will be taken For example, the high protein-low fat diet may be so unpalatable that it is not eaten This results in a large residue on the tray returned to the diet kitchen—food that is "on the order sheet but not in the patient" Therefore, in recent years the rigid high caloric high protein-low fat diets formerly prescribed in the treatment of liver disease have been sharply modified

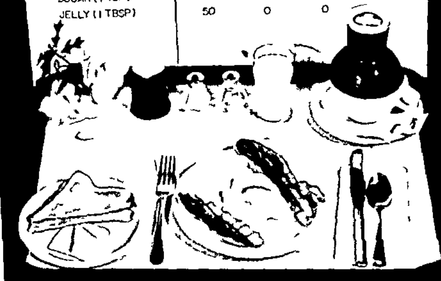


FIG 4—It is useful to know the caloric values of a few commonly used foods The capricious appetite of the seriously ill may be enhanced by an attractively served tray

(TABLE 7), for a strict low fat diet is likely to be so unappetizing that the necessary calories and protein are not consumed

In the average nutritionally depleted patient it is well to strive for an intake of perhaps 200 Gm of protein (divide by 6 25 to estimate grams of nitrogen) and 3,500 calories If this is well tolerated it may be possible to increase the total diet, but an intake of this magnitude (often not achieved) usually effects prompt nutritional improvement

Tube Feeding

Tube feedings are used to supplement oral intake It may be that the patient either cannot or will not otherwise ingest enough food Such circumstances are met in patients with oral or esophageal cancer, or in anorexia nervosa If the tube is not readily swallowed, it

TABLE 7—*Diet Hints for Different Conditions*

1 LIVER DISEASE
High protein high carbohydrate moderate fat diet Add methionine and/or choline and vitamins (especially vit K)

2 RENAL FAILURE
Low protein (less than 60 Gm /day) Adequate carbohydrate and fat for calories

3 POST GASTRECTOMY
Avoid high carbohydrate and fluid intake at mealtime 6–8 feedings/day Vitamin supplementation

4 SMALL BOWEL INSUFFICIENCY
Relatively high fat diet Frequent feedings (6–8/day) Banthine paregoric Kaopectate or Metamucil may be helpful

5 REALIMENTATION FOLLOWING PERIOD OF STARVATION
Begin easily assimilated materials slowly Avoid massive caloric intake until bowel and general metabolic tolerance increased

6 ACTH AND HYDROCORTISONE R_X
High protein high caloric diet Liberal daily oral potassium intake (12 Gm) Gastric antacids

7 LOW CALCIUM DIET
Avoid milk and milk products Normal daily urinary calcium excretion reduced to less than 300 mg

8 TUBE FEEDING
Basic ingredient skimmed or homogenized milk Add other caloric and protein supplements as tolerated

may be passed with the aid of an esophagoscope, or, a bag containing mercury (3 cc) can be tied to the tip of the tube, so that when passed through the nose the drag of the mercury bag will pull the end of the tube into the stomach The bag, if tied on with catgut, will soon be released by digestive action and passed per anus Or, it can be held initially by means of a silk thread drawn through the small tube itself, when the tube is in the stomach the thread is released above and the bag of mercury passes down the intestine

When conducted with care and persistence, feeding by nasogastric tube can be quite effective in many instances A small rubber Levin tube or a polyethylene tube is satisfactory Tubes of from 2 to 3 mm internal diameter will permit the introduction of thick feeding formulas and pureed or ground foods Skimmed milk is an available and well tolerated basic ingredient for feeding formulas To this may be added whole raw eggs, protein supplements (Gevral protein, Proteinum), and glucose (cartose) However, as noted above, whole foodstuffs can be homogenized in a Waring blendor and injected with a syringe

Complications of Tube Feeding Certain hazards, plus less serious but annoying developments may accompany tube feeding Among the more serious are esophageal erosion, perforation, or stricture and aspiration into the lungs due to an overfilled stomach Fortunately, esophageal damage is rare when small tubes are used but

pneumonitis due to regurgitation is not rare, especially in the obtunded subject Thus, it is well to give no more than 200 cc of the mixture at each feeding with feedings spaced at 2 hour or 3 hour intervals Furthermore, one should aspirate through the tube before each new feeding, lest further formula be introduced into an already distended stomach Another precaution is to aspirate the trachea prior to each feeding if tracheal aspiration is planned, otherwise, the patient's struggles might result in regurgitation of gastric contents with aspiration pneumonitis Elevate the trunk when feeding

More frequent complications of tube feeding are diarrhea, nausea, vomiting and bowel distention These are usually directly proportional to the concentration of calories and fat in the nutritive mixture The advantage of beginning with skimmed milk is that this material is well tolerated by most patients, and other ingredients can then be added gradually Often a feeding mixture may for several days cause diarrhea that must be controlled with measures such as paregoric Kaopectate and Banthine However, as a rule this problem subsides rapidly as the mixture becomes better tolerated and after a few days the medication to reduce the number of stools is no longer needed

Oral fat preparations (e g , Lipomul Upjohn) afford relatively large numbers of calories but excessive amounts may produce nausea, vomiting and diarrhea

Gastrostomy

There are some patients in whom nasogastric tube feeding is not feasible, and a gastrostomy must be done The simple Stamm procedure is suitable the stomach wall being inverted around a mushroom catheter in two layers, the seromuscular layer of the stomach is then sutured to the parietal peritoneum and the posterior rectus sheath Water is introduced through the tube the following day and thin formula the next

Complications occur also with gastrostomy These have to do chiefly with external leakage around the gastrostomy tube as it grows loose with difficulty in replacing a tube that has been inadvertently removed, and with leakage around the tube and into the free peritoneal cavity due to the separation of the stomach from the anterior abdominal wall Fatal peritonitis may result

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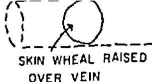
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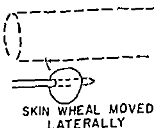
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STEP I

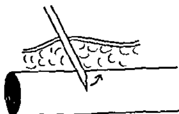


STEP II

TOP VIEW

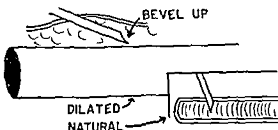


LATERAL VIEW



STEP III

LARGE VEIN



SMALL VEIN

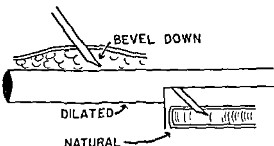


Fig 5—1 *Venipuncture* The technic of venipuncture consists of two basic steps (1) penetration of the skin and (2) entry into the vein Local anesthesia is used only when a large needle is to be employed If the insertion is likely to prove difficult the operator should sit and should use a syringe that will permit aspiration as required Blood specimens should be secured first and the needle then joined to the intravenous set for fluid administration A no 20 needle is adequate for fluids other than blood a no 19 being adequate for routine transfusion Where it is difficult to locate a suitable vein the substitution of a blood pressure cuff for the tourniquet plus moist heat with the arm dependent and the area under scrutiny briskly slapped with the fingers, will often cause a vessel of adequate size to become visible The use of a forearm or hand vein permits the patient to bend the elbow with the arm board applied distally Leg veins should be avoided for routine infusions where possible (Redrawn from Lundy J S Intravenous anesthesia Am J Surg *34* 559 1936)

from the introduction of gastrostomy mixture into the free peritoneal cavity Even so, the gastrostomy route is successfully employed for the nutritional maintenance of many patients

The same formulas or whole foods employed for nasogastric tube alimentation may also be given through the gastrostomy tube

Jejunostomy

A jejunostomy may be used to sustain life when no other expedient is feasible, but this route is far inferior to that afforded by gastrostomy Since there is little reservoir function, an almost continuous drip of a dilute caloric mixture is substituted for the intermittent 200 cc feedings given by gastrostomy tube Furthermore, hypertonic solutions quickly produce distention and diarrhea when given by jejunostomy, by virtue of the fact that water is drawn into the bowel

The defunctionalized loop (Roux-Y) jejunostomy is probably preferable to the simple Witzeled-in tube We have seen the latter pull out of the bowel, with resulting fatal peritonitis from the introduction of formula into the free peritoneal cavity

Here again, skimmed milk is often fairly well tolerated as an initial feeding material to which further simple materials such as glucose and protein hydrolysate may be added gradually

Intravenous Alimentation

The oral route is far superior to any other, for whole foods can be used The intravenous route has very decided limitations First, only very simple materials such as glucose fructose protein hydrolysates and alcohol have been used with consistent success, of course, whole food products cannot be infused Second, the veins readily available may become thrombosed early in the patient whose enteric fistula requires prolonged intravenous maintenance Third, despite some definite advances in recent years the calories that the average patient on intravenous alimentation receives are limited This is due to the fact that when concentrated solutions are infused intravenously much of the nutrient spills over and is lost in the urine Fourth it is not often that calories and amino acids are given in the proper proportions for optimal tissue formation

Yet, in many patients the intravenous route (FIG 5) must be

relied on, and many patients owe their lives to this expedient The introduction of only 400 calories per day has an important protein-sparing effect that should be taken advantage of whenever possible

Obesity as a Hazard in Surgery

The excessively obese patient is prone to develop numerous conditions which militate against optimal surgical results First, wound infections are more common due to the easily devitalized fat of the abdominal wall Second exposure within the abdomen is difficult Third, chronic cardiopulmonary disease may result from hypoventilation due to upward displacement of the diaphragm Fourth, the risk of anesthesia is greater Fifth diabetes, hypertension and atherosclerosis more commonly constitute a problem in obese subjects

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12 Pollack H and Halpern, S L Therapeutic nutrition Publication 234 Washington National Research Council 1952
13 Randall, H T Water and electrolyte balance in surgery Surg Clin North America *32* 1 1952
14 Watt B K and Merrill A L Composition of foods—raw processed prepared U S Department of Agriculture Handbook No 8 1950
15 Zimmermann B and Wangensteen O H Observations on water intoxication in surgical patients Surgery *31* 654 1952

used for what benefit it can provide, and it is useful to be aware of the nature and the caloric equivalents of materials that can be utilized They are as follows

1 000 cc of 5% glucose (50 Gm CHO)	200 cal
1 000 cc of 10% glucose (100 Gm CHO)	400 cal
1 000 cc of protein hydrolysate glucose (5% each)	400 cal
70 Gm of alcohol (7 cal /Gm)	490 cal
600 cc LIPOMUL IV (Upjohn)—15%	900 cal

In general, only 1 liter of fluid containing alcohol and 2 liters containing protein hydrolysate are well tolerated over one 24 hour period Although allergic reactions are rare, protein hydrolysate mixtures may at times precipitate alarming anaphylactoid phenomena, including urticaria, angioneurotic edema, and severe bronchospasm When one measures the loss of carbohydrate in the urine, he finds that considerable caloric losses occur by this route

Intravenous fat emulsions must perhaps still be considered as being in the experimental stage However, the reaction rate is now less than 5 per cent, and fatalities have been extremely rare Reactions include fever, jaundice, and red cell hemolysis Coagulation defects may develop during prolonged therapy Lipomul-IV (#11,612) in a 15 per cent concentration is the fat preparation most widely used in the United States at this time This emulsion is derived from cottonseed oil

Technic of Prolonged Vein Usage The more peripheral veins should be used first, with the more proximal ones left for the time when those on the fingers and hands have become thrombosed For if the proximal veins are used initially and become occluded, the more distal tributaries may be concomitantly involved by thrombosis

Hypertonic solutions cause a high incidence of venous thrombosis For this reason, it is often preferred to thread a plastic catheter into a femoral vein passing it up into the inferior vena cava where the large volume of blood flow quickly dilutes the infused hypertonic nutritive solution

Leg veins should be used only as a last resort, since thrombosis or thrombophlebitis in the lower extremity is much more disabling than in the upper extremity Of course, when it is necessary one can perform a cut-down on the long saphenous vein at the ankle just anterior to the medial malleolus

Despite the limitations of intravenous alimentation, it is often

relied on, and many patients owe their lives to this expedient The introduction of only 400 calories per day has an important protein-sparing effect that should be taken advantage of whenever possible

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4 *Blood Replacement and the Management of Shock*

BLOOD VOLUME AND COMPOSITION

THE AVERAGE HEALTHY adult male has a total blood volume of approximately 85 cc /Kg of body weight Thus, the blood volume in a subject weighing 70 Kg (154 pounds) would be almost 6 liters Since women usually contain more fat and less muscle than men of similar weight, their total blood volume per kilogram of body weight is somewhat less than that of males, as fat contains relatively little blood For the same reason, very muscular but lean individuals may have a blood volume that is considerably greater than 85 cc /Kg

Infants have a blood volume that is not greatly different from that of adults, on a weight basis For example, the 5 pound (2 3 Kg) baby may have a blood volume of not more than from 200 to 250 cc Obviously, careless hemostasis or failure to replace blood loss with precision can quickly result in disaster in the premature or the newborn

Where Blood Volume is Increased

Total blood volume is increased during pregnancy, though the *conspicuous variation here lies principally in the direction of a* relative or "physiologic' anemia Chronic hypoxia (as in high altitude dwellers, in patients with right to left heart shunts, or in certain pulmonary lesions) may result in an increase in the red cell mass and, at times, in the total blood volume Polycythemia vera results in an increased total blood volume, as does intensive physical training for competitive games

Where Blood Volume is Diminished

Aside from the obvious and most common blood deficit that is due to acute massive hemorrhage, marked variations occur due to such conditions as slow chronic hemorrhage, malnutrition

malignancy, hypersplenism and dehydration The patient who has extensive cancer is particularly apt to exhibit hypotension during the induction of anesthesia if he has not been transfused preoperatively It has been found that subjects with carcinoma of the esophagus, for example, may have a blood volume that is a liter below normal, in addition to the fact that the blood remaining may be lacking in red cell volume Of course, a part of the diminished blood volume in patients with malignant disease is due to malnutrition, but it is also true that certain tumors shorten the life span of the average red cell Interestingly, the blood volume may diminish during a period of bed rest, only to return promptly to normal when usual physical activity is resumed

Value of Hemoglobin and Hematocrit Levels

The red cells normally constitute approximately 46 per cent of the total blood volume, particularly of blood drawn from a large vein The hematocrit is, then, the percentage of a unit volume of blood (usually 100 cc) that is represented by the red cell volume The hemoglobin level is the weight of hemoglobin contained in 100 cc of blood Because the hemoglobin content of the individual red cell may vary in different types of anemia, and since the size of the red cell may also vary, the blood hemoglobin level does not necessarily reflect variation in the hematocrit level Finally, as a practical rule, the patient with a diminished hemoglobin level usually has also a diminished total red cell mass

The hemoglobin level and the hematocrit will be normal immediately after even a massive hemorrhage for, although the number of 100 cc units of blood has declined, there has not been time for hemodilution to occur, in contrast, if enough time has elapsed since the hemorrhage occurred, the hemoglobin and hematocrit levels will have fallen The vital function of respiration is dependent on the oxygen carrying capacity of hemoglobin In clinical practice, most surgeons rely on the hemoglobin and hematocrit levels as guides to the need for, and efficacy of, blood transfusion—aided by blood pressure and pulse rate measurements in the event of acute hemorrhage

Variations in Blood Composition

It has already been noted that the plasma and red cell volumes in the individual 100 cc unit of blood may vary widely under

different conditions, just as the total number of 100 cc units is abruptly reduced by acute hemorrhage Let us further emphasize certain of these variations that are of practical importance in surgery *It has been seen that a low red cell mass may be present* even when the total blood volume is normal, that is, an abnormally increased plasma volume may have compensated for the reduced red cell mass, to preserve a normal total blood volume In burn anemia or in the anemia of advanced cancer the hematocrit level, reflecting the red cell mass, may be only perhaps 25 per cent instead of the normal 46 per cent In the acute burn, on the other hand, red cell destruction may be minimal, hence, rapid loss of plasma results in red cell concentration so that the hematocrit may rise to perhaps 73 per cent Again, as indicated previously, in polycythemia vera or in the presence of an anoxic stimulus such as occurs in certain types of heart disease, pulmonary disease or high altitudes, the red cell mass may increase markedly This polycythemia is usually associated with an elevated hemoglobin value

Serum Protein Levels

A lowered serum protein level in surgical patients usually reflects a chronic disease such as cirrhosis, malnutrition, excessive exudate losses or malignancy While a lowered serum protein level does reflect a proportionate depletion of the general body protein reserves, the serum protein level is no longer widely used as a guide to transfusional therapy The reason for this is that, since the lowered serum level does indicate massive protein deficiency, it is now appreciated that it is inordinately expensive to attempt *to restore body protein reserves by means of blood or plasma* transfusions Therefore, the plan usually is to transfuse to render the blood volume and red cell mass adequate for surgery, the surgery is then directed toward restoring the ability of the patient to take a normal diet by mouth the only really effective means of restoring the metabolic reserves of protein

Nevertheless, it will be appreciated that a markedly lowered total serum protein level, usually associated with a reversed A G ratio has a serious prognostic import Such patients are prone to exhibit shock, infections, wound disruption and poor functioning of enteric anastomoses The normal serum protein level is approxi-

mately 7 5 Gm, representing 4 Gm of albumin and 3 5 Gm of globulin The albumin fraction is particularly important in maintaining the relatively small but highly significant colloidal osmotic pressure, but the globulin fractions are especially prominent in the immune mechanism, blood clotting, and other complex processes

BLOOD REPLACEMENT

The maintenance of a blood volume that is neither inadequate nor excessive constitutes a major activity in surgical practice In fact, the extensive operations performed daily in most larger hospitals would be impossible without the well managed blood bank Therefore, an awareness of the physiologic considerations attendant upon rapid blood volume alterations is essential to effective modern surgical care

Indications for Transfusion

Unquestionably much blood is given unnecessarily This practice causes hazards and expense that should be avoided For example, the simple cholecystectomy or thyroidectomy does not require a blood transfusion, if reasonable hemostasis is maintained throughout the operation And this patient is then not exposed to the risk of serum hepatitis or a transfusion reaction

Nevertheless, for radical neck dissection, gastric resection, colon surgery, pulmonary resection and, above all, for aortic and cardiac surgery, adequate amounts of blood must be available The amounts of blood that are commonly requested are shown in TABLE 8 Of

TABLE 8—*Volume of Blood to be Available for Various Operations**

Abdominoperineal Resection	2,500 cc
Cholecystectomy	500 cc
Colon Resection	1 000 cc
Gastric Resection	1 500 cc
Hysterectomy	1 000 cc
Pulmonary Lobectomy	2 500 cc
Radical Mastectomy	1 500 cc
Radical Neck Dissection and Hemimandibulectomy	2 000 cc
Resection Large Aneurysm	5 000–10 000 cc
Thyroidectomy (Large Gland)	500 cc

* These values represent average requirements only Blood loss during surgery is a function of rate and time Transfusion is avoided unless essential

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prevent such changes Furthermore often larger volumes of blood transfusion are required to recover from shock than to prevent shock from developing

There is no substitute for firm physiologic control of the patient at all times To attempt to "out-run shock by operating faster, rather than to avoid further hemorrhage until blood loss has been replaced, constitutes poor judgment in most instances For this reason, among others the surgeon and the anesthetist must continuously exchange information regarding rates of blood loss and blood pressure measurements especially where significant bleeding is or can be a problem

Since one does not wish to wait until the onset of hypotension underscores the need for blood transfusion, how can the need be estimated in the absence of a fall in blood pressure? One can use dry sponges of known weight and then weigh each sponge after it has been used the difference between dry weight and wet weight is taken to reflect cc of blood loss Or, one can use suction for removing most of the blood from the operative field and collect the blood in a graduated trap bottle Of course, both sponge-weighing and suction are often used, and this is ideal However, for most operations the suction trap bottle is the most practicable, since the time of the circulating nurse is thus not required to weigh the sponges Moreover, where blood loss is rapid and massive the sponge-weighing is cumbersome, here observation of the suction trap bottle and blood pressure measurements are the more immediately practical guides

When the blood pressure falls in an adult one can be assured that at least 500 cc of blood, and usually more, has been lost Hence, one pint should be infused rapidly and then another begun It follows that there must be available a technic for pumping blood into the vein Either a cut-down on the saphenous vein at the ankle (FIG 6) or a plastic catheter of suitable diameter threaded well up into a vein (FIG 7) is essential to the safe conduct of pulmonary and cardiovascular surgery In general two venous avenues for the infusion blood should be prepared in such patients

Complications of Blood Transfusion

Blood transfusion is not devoid of complications, which range f minor reactions to fatal renal shutdown Aside from excessive t

course, not all the volume indicated may be required, but the volume on hand must be at the upper limit of that which may be used Since one may transfuse as much as 20 liters in managing a ruptured aneurysm, the indispensability of the blood bank in the practice of vascular surgery is apparent Hypovolemic shock may result in cardiac arrest or brain damage immediately, or in renal shutdown in the postoperative period

Preoperative Blood Replacement In the management of acute blood loss preoperatively one must depend primarily on blood pressure measurements and the pulse rate More often, however, preoperative transfusions are for the purpose of replacing chronic blood loss, where there has been time for the red cell mass to be diluted by passage of water into the blood stream to augment the plasma volume Here the hematocrit and hemoglobin levels will be reduced, and the effect of transfusion upon these values may be followed to gauge the amount of blood needed in replacement

When a liter of blood is given slowly to an anemic subject, the total blood volume is not usually increased by one liter Actually, the volume of increase may be equal to little more than the volume of the red cell mass infused This is because much or most of the plasma given leaves the circulation Therefore, in the elderly subject who is quite anemic one need not be too concerned that overloading of the circulation will occur, if the transfusions are not given too rapidly, up to 2 liters of blood are well tolerated at a rate of one transfusion per day In such patients it is well to allow from 24 to 48 hours for cardiovascular adjustment to the restored blood volume before surgery is performed, however

The hemoglobin and hematocrit values need not always be restored to completely normal levels, but the normal level should be approached before surgery is begun Needless to say, additional blood must be ready for use during the operation (see TABLE 8)

Transfusion During Operation In operations whose nature assures that blood transfusion will be required sooner or later, it is well to begin replacement before the loss has been such as to produce a fall in blood pressure There can be no question that the intelligent *prophylaxis* of oligemic shock is much to be preferred to the treatment of the established condition That is, shock permits metabolic changes to occur, due to varying degrees of tissue hypoxia, that are not always readily reversible It is far better to

prevent such changes Furthermore, often larger volumes of blood transfusion are required to recover from shock than to prevent shock from developing

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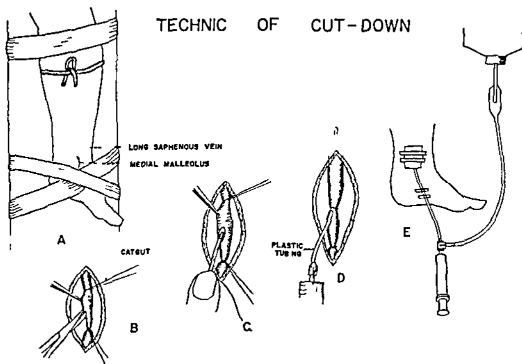


FIG 6—The cut-down affords much security when blood must be infused rapidly under pressure Either a vertical or horizontal skin incision is satisfactory The use of catgut ligatures avoids chronic granulomas due to infection around a silk nidus Where the inferior vena cava may be occluded as in resection of an abdominal aortic aneurysm it is wise to insert a Rochester needle (FIG 7) in an arm vein, in addition to the cut-down in the leg The antecubital and cephalic veins are also readily available for cut down if required

fusion the untoward sequelae most frequently met are mild allergic reactions manifested by fever, perhaps with a chill, and urticaria or similar phenomena, or various aches and pains due to incompatibility of minor blood groups or similar immunologic manifestations Most serious of all, most inexcusable, but fortunately relatively rare—reactions due to major blood group incompatibility are often fatal Death may occur within hours due to "anaphylactoid shock" or to uncontrollable bleeding, quite often however, an irreversible renal shutdown occurs

In addition to the obvious requirement of major blood group compatibility in blood transfusion care must be exercised that an Rh negative recipient not be sensitized with (and to) Rh positive blood The use of type O ("universal donor) blood for patients with other blood groupings is not without hazard, and it should be "titered ' and used only when the titer is low and an actual emergency exists

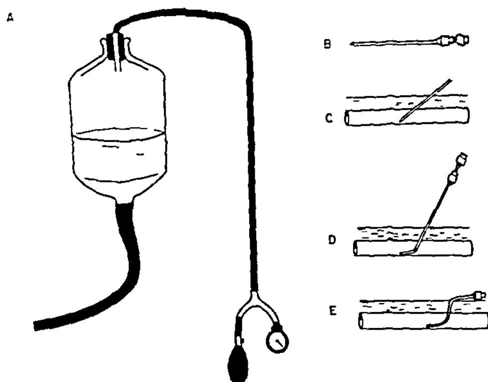


FIG 7—(A) For operations in which a large volume of blood may be lost rapidly some means of pumping in blood is required since gravity flow is often inadequate It is essential that air not be forced into the vein as the column of blood nears the bottom of a flask (B) The Rochester ' needle consists of a piece of plastic tubing into which a stylette has been passed The tubing comes in various sizes one having an internal diameter equivalent to that of a no 15 gauge needle being satisfactory in adults After the tip of the tubing has been inserted well into the vein by means of the stylette (C) the stylette is withdrawn (D) and the plastic tubing is then advanced still farther into the vein (E) This plastic cannula is used in lieu of a cut-down for the rapid infusion of blood (Available from Rochester Products Co Rochester Minnesota)

MANAGEMENT OF SHOCK

The intelligent management of shock requires a diagnosis of the cause The normal blood pressure is maintained through the concerted roles of the heart, the blood volume and the peripheral resistance The failure of any one or more of these factors will result in arterial hypotension Myocardial infarction, severe hemorrhage and high spinal anesthesia represent examples of each of the three mechanisms, respectively While it can be argued that hypotension *per se* does not constitute shock with the usual associated metabolic derangements, for practical purposes the patient whose blood level has fallen from 120 systolic to 80 systolic is in shock Certainly it is

wise to assume that shock exists and to treat it promptly, for most of the time it does exist Common causes of shock during and following operation may be listed

A SHOCK DURING OPERATION
  (1) *Inadequate blood volume*
    (a) Preoperative deficit plus vasodilation under anesthesia
    (b) Hemorrhage during surgery
  (2) *Defective anesthesia*
    (a) Excessive dosage
    (b) Inadequate pulmonary gas exchange leading to hypoxia and/or hypercapnia (carbon dioxide retention)
  (3) Transfusion reaction
  (4) Noxious reflexes due to traction on viscera or other causes
  (5) Compression of vena cava
  (6) Heart failure
  (7) Miscellaneous pulmonary embolus adrenocortical insufficiency and others

B SHOCK IMMEDIATELY FOLLOWING OPERATION
  (1) Further hemorrhage or unreplaced deficit
  (2) Prolonged anesthetic effects perhaps due to hypoxia relaxant drug or anesthetic agent
  (3) Excessive opiate administration particularly in the elderly
  (4) Infection (endotoxin shock)
  (5) Pulmonary atelectasis or other causes of defective ventilation
  (6) Miscellaneous adrenocortical insufficiency coronary occlusion translocation of fluids liver failure hemiplegia pulmonary embolus and occasionally pre-existing electrolyte disturbances

Clinical Shock An Illustrative Case

S M a 65 year old white male was admitted to the University Hospital for profuse rectal bleeding of undetermined origin Sigmoidoscopic examination to 20 cm revealed only that fresh blood was flowing from above this point Two transfusions were given throughout the night to sustain the blood pressure and the following morning an emergency barium enema revealed multiple diverticula of the colon One segment of the sigmoid colon was particularly involved and the mucosal pattern suggested acute inflammatory changes The routine chest film revealed extensive changes in the destroyed right lung with a shift of the trachea and mediastinal structures in that direction

Following the diagnostic barium enema no further blood was passed per rectum The blood hematocrit level had been 45 on admission and was now 42 However in view of the bleeding which this elderly patient had sustained it was elected to prepare him for resection of the most heavily diseased portion of the sigmoid colon Ten days after admission the abdomen was opened under cyclopropane anesthesia and a careful exploration was carried out A duodenal diverticulum that had been demonstrated by roentgen study did not appear to be a likely source of hemorrhage As the small bowel was being packed off to permit adequate exposure and resection of the involved portion of the sigmoid colon the anesthesiologist announced that the blood pressure previously normal was suddenly unobtainable This diagnosis of shock was promptly confirmed by palpation of the abdominal aorta where pulsations were extremely weak

Immediate therapeutic measures were taken in approximately the following order

(1) The patient was placed in a fairly steep *Trendelenburg position* (to "transfuse" from the leg veins and to facilitate oxygenation of the brain)

(2) *Pulmonary ventilation* was vigorously assisted by rapid manual compression and release of the gas bag

(3) A *vasopressor drug* (neo-synephrine) was utilized temporarily to elevate the blood pressure being given by vein

(4) *Blood* (500 cc) was pumped in

(5) The surgeon checked again to be certain that there was no undue traction on the mesentery of the small bowel and that no retractor was compressing the inferior vena cava

The result of these measures was that the blood pressure rapidly returned to a systolic level above 100 mm Hg At this point however the consensus was to abandon the planned segmental colon resection for the time being and the abdomen was closed The patient made an uneventful recovery

Discussion The cause of the shock was not identified, but several possibilities were likely There had been no further bleeding since the original episode at the time of admission, and the preoperative hematocrit level was 42 Furthermore, the patient had been transfused preoperatively Even so, an *inadequate blood volume* may have been a contributing factor A moderate degree of oligemia was perhaps further aggravated by the vasodilatation which accompanied the induction of general anesthesia, though this effect is often much more marked when spinal anesthesia is used The measures taken to combat possible hypovolemia were the Trendelenburg position, the vasoconstrictor drug and blood transfusion

Respiratory insufficiency may also have been a factor in the shock exhibited by this particular subject The right lung had been virtually destroyed by previous tuberculosis, with a right mediastinal shift and overdistention of the left lung The possibility of inadequate oxygenation had to be considered Moreover, the marked deformity of the trachea may have partially occluded the tip of the endotracheal tube

Hypoxia is a very effective means of producing shock during anesthesia

However, since the bleeding in the abdominal wound had not indicated cyanosis, the possibility existed that the high oxygen concentration in the cyclopropane gas mixture might have maintained adequate oxygenation while permitting excessive CO_2 accumulation to occur Since the soda lime cannister had just been changed, any CO_2 accumulation would perhaps have been due to inadequate ventila-

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In making a prompt diagnosis of acute adrenocortical failure, one may be assisted by a history of corticosteroid therapy in the past, or by remembering that metastases from the lung and other tumors often involve the adrenal glands However, when shock persists after adequate blood transfusion and pulmonary ventilation has been achieved, especially when hyperthermia is present and there is no reason to suspect brain damage or septicemia, one should begin a therapeutic trial of intravenous hydrocortisone This steroid comprises more than 80 per cent of the corticosteroid secretion of the adrenal cortex in man and possesses, in some degree, all the known corticosteroid effects An intravenous infusion containing 100 mg of hydrocortisone should be given over each six hour period Moreover, it is our practice to "cover" with hydrocortisone therapy any patient who is known to have had corticosteroid therapy in the past several years We had occasion to examine at laparotomy the left adrenal of a man who had received hydrocortisone for arthritis for many months Almost no recognizable adrenal tissue remained, due to atrophy of the organ under hydrocortisone therapy This clinical finding was sustained by the finding of a preoperative plasma free 17–21-hydroxycorticosteroid level of zero (normal, 7 to 15 micrograms per cent) and a conjugated level of zero (normal, 2 to 5 micrograms per cent) Moreover, the level of free steroid in the adrenal vein blood taken at surgery was only 10 micrograms per cent, the average value in normal subjects being approximately 200 micrograms per cent The findings in this patient document the hazard of performing major surgery on an individual who has had prolonged steroid therapy

Hydrocortisone and related compounds are useful in other clinical circumstances Allergic reactions, perhaps caused by an intravenous infusion, usually respond rapidly to intravenous hydrocortisone The effect of a dose of hydrocortisone injected intravenously has been found to last about 4 hours

Cortisone has gradually been largely replaced by hydrocortisone, and the latter is giving way to some extent to prednisone and prednisolone These newer analogues are reported to have a significantly greater anti-inflammatory potency but less salt-retaining effect than cortisone and hydrocortisone

Since there is little storage effect, the conspicuous complications of steroid therapy are rarely encountered with short-term therapy

tion of the pulmonary alveoli or to inadequate alveolar membrane surface for rapid gas exchange with the blood

Or, the patient may have had chronic cor pulmonale due to pulmonary fibrosis with pulmonary hypertension, the right heart may have temporarily faltered when pulmonary hypertension became unusually high

In retrospect, a spinal anesthetic might have proved more suitable in this patient

Use of Corticosteroids in the Management of Surgical Shock and in Other Conditions

When a patient is in shock and the etiology is not apparent, the question usually arises as to whether or not adrenocortical failure is present Needless to say, the more common factors such as oligemia, respiratory insufficiency and infection must be excluded first However, there is the very occasional patient whose shock is in fact due to adrenocortical failure How is the diagnosis made and what therapy is recommended?

Adrenocortical failure manifests itself in three general guises, depending on the rapidity of onset The patient with *chronic adrenocortical failure* (Addison's disease) will have lost weight, water, sodium and chloride The serum potassium level and the N P N are elevated The fasting blood sugar level is often depressed In sharp contrast, the *acute adrenocortical failure* that occurs during the 24 to 48 hours following surgery is manifested by an elevation of body temperature and pulse rate, a fall in blood pressure, oliguria and disorientation There has not been time for the plasma chemistry values to change significantly and, of course, the plasma and urinary steroid measurements are far too time-consuming to be of value in the acute emergency *Subacute adrenocortical failure,* with an intermediate rate of onset is heralded by fatigue, confusion and anorexia, associated with beginning changes in the plasma chemistry values as outlined above for the chronic type of onset Particularly valuable are the lowered plasma sodium level and the elevated N P N The subacute type is usually not associated with the abrupt hypotension, hyperthermia and oliguria that are so characteristic of acute failure

A failure of the total eosinophil count to fall to or near zero following surgery is of some confirmatory value in the patient suspected of having adrenocortical insufficiency

5 *Abnormal Bleeding (Coagulation Defects)*

THE PRESENT DAY use of massive transfusions and multiple intrathoracic operations has resulted in an increased incidence of abnormal bleeding Thus it is not surprising that surgeons generally have become alert to some of the hazards which can result in coagulation defects Some of the more common causes of postoperative hemorrhagic states will be considered and a general plan of management will be given Since it is often not simple to identify quickly the cause of the excessive postoperative oozing the therapy must usually be of a general and comprehensive nature, to cover at least most of the coagulation defects that might exist This is especially true at night when the coagulation laboratory is closed

THE NORMAL CLOTTING MECHANISM

The basic steps in clotting remain the conversion of prothrombin to thrombin, and then the interaction of thrombin and fibrinogen to form fibrin Clot retraction and, later, fibrinolysis are also important segments of the total coagulation process

In recent years much interest has centered around the factors which promote the conversion of prothrombin to thrombin, for this is a very complex mechanism Nevertheless, in simplified form one current outline of blood coagulation is as follows, a number of details being omitted for the sake of simplicity

Step I FORMATION OF THROMBOPLASTIN

The formation of thromboplastin has been shown to be the result of a very intricate series of chemical reactions Components are derived from both plasma and platelets One example of the plasma group is anti hemophilic globulin (AHG) absence of which results in hemophilia Once sufficient thromboplastin has been formed Step II begins

Step II CONVERSION OF PROTHROMBIN TO THROMBIN

Thromboplastin combines with or acts upon prothrombin in the presence of calcium ions to form thrombin However this conversion is abnormally slow and inefficient without the activity of the so-called accelerating factors referred to as Factors V (*labile factor*) and VII (*stable factor*) Although

Such complications are, for the most part, exaggerations of usual physiologic effects of corticosteroids, and many of them are characteristic of Cushing's disease Among these are purplish striae, moon face, obesity, hirsutism, muscle wasting glycosuria, peptic ulceration, amenorrhea, osteoporosis and personality changes

Adrenocortical function and replacement therapy are discussed somewhat further in connection with adrenal surgery (p 210)

REFERENCE

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Massive transfusions of stored blood often lower the platelet count The transfusion of fresh blood may supply enough platelets to correct this problem, but *if fresh blood is not available it may be* safer to maintain blood volume with plasma or plasma expander, allowing time for the patient to form his own platelets Stored blood has a diminished capacity to promote clotting, due to reduced amounts of platelets, Factor V, prothrombin, fibrinogen, and increased amounts of citrate Of course, patients with liver disease may have depressed prothrombin levels, and patients with splenomegaly may have a lowered platelet count due to hypersplenism

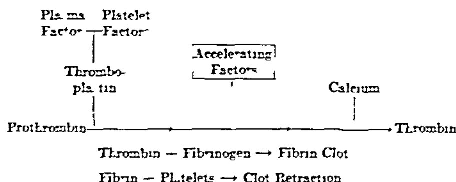
TREATMENT OF HEMORRHAGIC DIATHESES

Preoperative Evaluation While one cannot and need not investigate the clotting mechanism exhaustively in every patient (to do so would be excessively costly), certainly the individual whose history and diagnosis suggest abnormal bleeding should be carefully evaluated The adequacy of platelets, and the tourniquet test, bleeding time, clotting time and clot retraction are easily assessed The prothrombin level is readily measured, and the prothrombin consumption and the plasma fibrinogen level can be determined If these are abnormal, further more selective and specific identifying procedures are indicated, as noted above Patients with liver disease may require vitamin K_1 oxide to elevate the levels of prothrombin and of Factor VII (stable accelerator) If Factor V is deficient, fresh plasma or whole blood *may* be required at *operation Fresh whole blood or* platelet transfusion *per se* is needed for surgery if platelets are deficient If surgery must be performed in the hemophiliac, the administration of lyophylized AHG or fresh whole blood will sustain coagulation during operation

Abnormal Bleeding During and Following Operation Many of the measures referred to above are applicable Bleeding during surgery may be due to any or most of the factors that have been presented in the scheme of blood coagulation However, shock and transfusion reaction may liberate circulating anticoagulants, or massive transfusion of old blood with low platelet counts may result in thrombocytopenia In any event, the same general therapeutic measures apply They are as follows

(1) *Fresh whole blood* (less than 6 hours old) to supply platelets and other components (such as AHG) that are required for the formation of thromboplastin Fresh whole blood (or plasma) also supplies prothrombin Factor V Factor VII and fibrinogen

the action of thromboplastin with prothrombin can result in some thrombin abnormal bleeding may occur if due to a deficiency of Factor V and VII the conversion of prothrombin is too low



Actively opposing the coagulation process (in contrast to a deficiency of various needed substances) are materials such as antithromboplastin antithrombin (*e g* heparin) and fibrinolysin

DIAGNOSIS OF HEMORRHAGIC STATES

Abnormal bleeding may be due to the failure of any one or more of the components of the coagulation mechanism Hence the diagnosis of the specific biochemical lesion may require the services of a coagulation laboratory in order to pinpoint the defect This type of selective identification is achieved by evaluating every step of the clotting mechanism Of course certain clinical conditions are somewhat more likely to be associated with one defect than another The patient who has been a bleeder all his life may be an hemophiliac or he may have idiopathic thrombocytopenia or hypoprothrombinemia In the hemophiliac there is a deficiency of antihemophilic globulin (AHG) which functions in the formation of thromboplastin.

In general, the coagulogram may disclose deficiencies involving one or more of the following AHG platelets prothrombin Factor V Factor VII or fibrinogen Or the presence of *circulating anticoagulants* which oppose the normal function of various of the factors involved in normal blood clotting may be identified Thromboplastin deficiency whatever the cause may be revealed by means of the prothrombin consumption test The fibrinogen concentration in plasma can be measured but a useful qualitative test consists of placing topical thrombin in a drawn blood specimen If clotting does not occur then a fibrinogen deficiency is assumed and the patient is treated with intravenous fibrinogen

The hematuria (microscopic) found on urinalysis had been considered to be due to pressure of the mass on the left urinary tract and the history of mild rectal bleeding had been considered to be due to the large internal and external hemorrhoids that were visualized

Laparotomy was performed using a long midline incision There was no free blood in the peritoneal cavity There was a very large left retroperitoneal mass which extended from the diaphragm to the pelvis This mass was obviously not constituted largely by recent hematoma but the characteristics of a ruptured aneurysm (position transmitted pulsation etc) were present in sufficient degree to warrant precautionary control of the aorta above and the common iliacs below before the mass itself was incised This required some 20 minutes of dissection and during this period there was much oozing from retroperitoneal surfaces that usually bleed very little However even the surgeon was startled somewhat later in the operation when upon requesting the anesthesiologist to give another pint of blood he was informed that 5 pints had been given already By this time with a clamp around the aorta but not closed the mass had been boldly incised Numerous collections of either pus or liquefaction necrosis were drained amid much necrotic tissue in the region of the left kidney and the subdiaphragmatic space

By this time there was very extensive oozing Since the aorta was not involved by aneurysm and the mass (if tumor) obviously not resectable the abdomen was closed with flank drainage However so freely did blood emerge from the drain site that the fascial and peritoneal sutures were removed and actively bleeding points sought Unfortunately no large bleeders were found to be ligated for hemostasis there was a generalized ooze involving all exposed surfaces Moreover by this time the patient had begun to bleed from his gums and gross hematuria was observed emerging from the urethral catheter There was no reason to suspect mismatched blood as a cause of the abnormal bleeding

Postoperative Course Inasmuch as the operation was being performed at night the pathologist was not called for a frozen section although all felt that the lesion represented some highly cellular tumor with extensive necrosis Nor was the hematologist called out to perform a coagulogram to identify the specific coagulation defect Thus we found ourselves in the usual clinical situation of extensive oozing without precise knowledge of the cause The patient reacted promptly from the anesthesia

The therapy was as follows

(1) *Blood transfusion* as required to maintain a normal blood pressure and later a normal hematocrit level (No blood given during the night was more than 5 days old though later some older blood had to be used) The next morning two pints of freshly drawn blood were infused to supply AHG platelets and Factor V

(2) *Vitamin K oxide* (100 mg) was given at a slow drip intravenously (to combat a possible lowered level of prothrombin and Factor VII)

(3) *Protamine sulfate* was given intravenously (to combat possible heparinoid endogenous anticoagulants)

(4) *Fibrinogen* was given intravenously (to combat a possible deficiency of fibrinogen and increased fibrinolysis)

(5) *Vitamin C* was given (to combat any possible scorbutic tendency)

(6) *Calcium gluconate* was given intravenously (empirically for we did not really believe it was needed)

(2) *Vitamin K₁* may be required by the liver to provide normal amounts of prothrombin and Factor VII Factor V (labile factor) is influenced little by vitamin K₁ therapy but, as seen above it can be supplied with fresh whole blood

(3) *Fibrinogen* is given intravenously when the defect is due to hypofibrinogenemia As a clinical test if the blood will not clot when topical thrombin is added, hypofibrinogenemia must be strongly suspected and treated with fibrinogen and blood transfusion

(4) *Circulating (endogenous) anticoagulants* may be neutralized with injections of protamine sulfate or at times with toluidine blue

(5) *Female hormones (e g Premarin)* have been reported to be of value in the spontaneous hemorrhage of pulmonary tuberculosis and *vitamin C* has long been used *Adrenal corticosteroids* have also been given and they may particularly facilitate a rise in the platelet count However none of these three types of therapy has the importance of fresh whole blood vitamin K₁ and fibrinogen

Unligated Vessels *Versus* Hemorrhagic State Differential Diagnosis

The commonest "bleeding diathesis" is that due to inadequate technical hemostasis at surgery When the patient continues to bleed during the postoperative period, it is often very difficult to know whether the bleeding is due to a coagulation defect or to unligated vessels In general, if the blood clots promptly on standing and platelets are present in the peripheral blood in adequate numbers then one must strongly suspect that the hemorrhage is due to unligated vessels, for which reoperation may be required

ABNORMAL BLEEDING AN ANNOTATED CASE STUDY

History M W a 56 year old white man had not been well for several months when he consulted his physician for pain in the left upper quadrant of the abdomen and back He was hospitalized and an intravenous urogram revealed extrinsic pressure on the left kidney and a few days later a mass was palpated in the left flank There was some hematuria mild rectal bleeding was thought to be due to the large hemorrhoids His pain became markedly worse and his local physicians suspecting the possibility of a ruptured abdominal aneurysm rushed him to the University Hospital by ambulance on April 23 1958

Evaluation on Admission Rapid examination revealed a patient in severe pain whose most prominent finding was a large pulsating tender mass which extended from the left costal margin far around into the flank and down toward the pelvis He was mildly febrile and not in shock

The hemoglobin level was 12 5 Gm and the hematocrit 36 volumes % There were innumerable red blood cells in the urine The white blood cell count was reported as 11 000/cu mm with a normal differential

All in all it appeared quite possible that the patient did have a ruptured aneurysm of the abdominal aorta Accordingly as soon as a sufficient amount of compatible blood was ready he was taken into the operating room At this point a finding was noted which should have alerted us to all the trouble that followed A venipuncture site was in only a few minutes surrounded by a relatively enormous hematoma

4 Much remains to be learned regarding the causes and treatment of defective blood coagulation

REFERENCE

1 De Nicola P Coagulation Defects Springfield Illinois Charles C Thomas, 1956

(7) *Hydrocortisone* was given intravenously (to permit a possibly low platelet count to rise)

And still he bled

By this time it was morning and the hematologist and the coagulation laboratory were called upon for assistance To underscore the patient s grasp of the situation He stated that he would bleed to death if we did not stop the bleeding from his abdomen (through the drain site) and incidentally from the urinary tract as well with bladder clots being repeatedly lysed with streptokinase streptodornase to permit urine flow There was some clotting around the drains but the clot was soft friable and jelly like and no clot retraction (a function of platelets) was noted

Hematologic consultation revealed that the preoperative blood smear had been incorrectly interpreted At that time the platelets had been reported present in normal numbers but actually they had been extremely rare in the smear A current platelet count revealed virtual absence (21 000/cu mm as against a normal of 100 000 of these blood elements) Thus one major element of normal blood coagulation was lacking—platelets which not only supply an important *thromboplastic component* but are also almost solely responsible for the highly important *clot retraction* without which effective hemostasis usually is not achieved Second the clotting time was 41 minutes (normal usually below 10) the first stage prothrombin time was 30 per cent but corrected to 100 per cent on addition of Factor VII and clot retraction was only approximately 3 per cent and 10 per cent of normal on two separate studies

In essence the major defect was a severe thrombocytopenia with almost absent clot retraction The increased clotting time was brought down to 9 minutes by the slow intravenous infusion of a specially prepared brain extract which supplied additional thromboplastic element Thus whereas the *prolonged clotting time* due perhaps to inadequate thromboplastin (p 42) was improved the *prolonged bleeding time* due to inadequate blood platelets was not improved even with the several bottles of freshly drawn blood that were available

The bleeding did gradually diminish markedly but it never stopped completely and the patient died three days following operation although he did not actually exsanguinate The widespread tumor by then diagnosed as either reticulum cell sarcoma or lymphosarcoma (stem cell type) contributed substantially The low platelet count was considered to be due to bone marrow replacement by the sarcoma

Comment on Case

This case illustrates a number of points that usually arise in such patients

1 That a serious coagulation defect exists is often not clearly appreciated until the operation is under way

2 Treatment usually is administered empirically to cover most of the known possible causes of defective blood clotting

3 Despite the reassuring orderliness of coagulation diagrams, therapy in the actively bleeding patient is frequently rather ineffective

teenth postoperative day After this there is further maturation and gradual reorganization of the biochemistry and histology of the wound but little further increase in the strength of the incision occurs

Skin sutures may be removed from most abdominal wounds on the fifth or sixth day Due to the stresses to which the skin of the back and other extensor surfaces are subjected skin sutures in incisions involving the shoulders or back should be left for a longer period of time, often for eight days or until skin healing has obviously occurred Incisions in the breast during pregnancy are particularly likely to heal with a widened scar, and hematoma formation is common due to the marked vascularity near term, careful reapproximation of breast tissue and skin is quite important While a wound may not actually separate when sutures are removed too early, the separation of the subcutaneous elements beneath the epithelized surface may result in a widened and unsightly scar Sutures are removed from face incisions on the second or third day, unless white subcuticular sutures have been used and buried (The color of subcuticular suture used will depend upon the color of the skin, it is important that the sutures not be visible through the overlying epithelium) Clinical judgement must be exercised as to the optimal time for removing the sutures from any given wound (TABLE 9)

Catgut sutures are generally used in anorectal (hemorrhoidal) surgery, and for the closure of incisions in the tongue and mouth These will be absorbed and need not be formally removed

Types of Wound Healing (FIG 8) Wounds may heal promptly with primary closure (*first intention*) Or, the sutures may be placed but not tied down for a day or so, until the probability of serious infection has passed, this is called delayed primary closure Second, the wound may be left open to granulate in Third, the margins of

TABLE 9—*Skin Sutures Suggested Time for Removal*

1 Face—half on 2nd P O D rest on 3rd P O D
2 Thyroid incision—2nd or 3rd P O D
3 Radical mastectomy—5th to 7th P O D depending on appearance and degree of healing
4 Back and other extensor surfaces—varies but risk of wound separation or widening of scar prompts caution sutures out on 8th or 10th P O D
5 Posterolateral thoracotomy incision—half on 6th P O D rest on 8th P O D
6 Abdominal incisions—on 5th to 7th P O D depending on appearance of wound

6 *The Wound and Its Management*

THE GOOD TECHNICIAN never loses pride in the appearance of his operative incision Yet, wound healing is so commonplace that one is always a bit surprised when even a long skin incision does not heal promptly There are many factors, both positive and negative, which influence the quality of repair Some of these factors will be presented and the management of wound complications will be outlined

GENERAL COMMENT

The repair of an incision is conducted with multiple considerations in mind First, of course, the abdominal or thoracic cavity closure must be secure lest evisceration or at least hernia formation occur Second, the skin scar should be as pleasing to the patient as possible

One always seeks to be certain of firm closure of the wound that has entered a coelomic cavity, since dehiscence would seriously threaten the patient's life To achieve this primary requirement it may be necessary to forego certain cosmetic desiderata in some cases For example when an intra-abdominal abscess has been drained, one frequently closes the skin very loosely or not at all, this is to prevent the formation of an abscess in the abdominal wall that might weaken the fascial closure and also debilitate the patient Under these circumstances the healed scar in the skin will not present as desirable a cosmetic result as it would if it were appropriate closely to approximate the skin margins initially Similarly, through and through stainless steel wire sutures usually produce an unsightly scar, since the wire sutures leave their own imprint in the form of as many fine scars criss-crossing the main incisional scar

Stages and Timing of Wound Healing In general, the strength of the wound during the first five days is due to the suture material Thereafter there is a rapid increase in the strength of the fascial closure due to the infiltration of the fibrin clot with fibroblasts This fibroblastic proliferation *has reached its maximum by about the six-*

teenth postoperative day. After this there is further maturation and gradual reorganization of the biochemistry and histology of the wound but little further increase in the strength of the incision occurs.

Skin sutures may be removed from most abdominal wounds on the fifth or sixth day. Due to the stresses to which the skin of the back and other extensor surfaces are subjected, skin sutures in incisions involving the shoulders or back should be left for a longer period of time, often for eight days or until skin healing has obviously occurred. Incisions in the breast during pregnancy are particularly likely to heal with a widened scar, and hematoma formation is common due to the marked vascularity near term; careful reapproximation of breast tissue and skin is quite important. While a wound may not actually separate when sutures are removed too early, the separation of the subcutaneous elements beneath the epithelized surface may result in a widened and unsightly scar. Sutures are removed from face incisions on the second or third day, unless white subcuticular sutures have been used and buried. (The color of subcuticular suture used will depend upon the color of the skin; it is important that the sutures not be visible through the overlying epithelium.) Clinical judgement must be exercised as to the optimal time for removing the sutures from any given wound (TABLE 9).

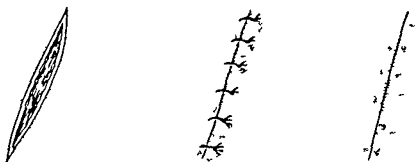
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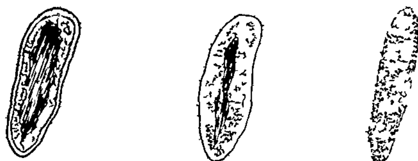
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5. Posterolateral thoracotomy incision—half on 6th P.O.D., rest on 8th P.O.D.
6. Abdominal incisions—on 5th to 7th P.O.D., depending on appearance of wound

FIRST INTENTION



SECOND INTENTION



DELAYED SUTURE

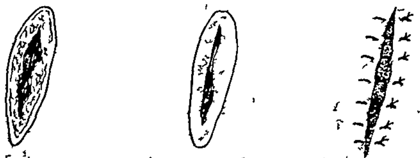


FIG 8—*Types of Wound Healing First Intention* The immediate and careful suture of the wound results in optimal healing *Second Intention* To allow the defect to granulate in and finally close by scar tissue and a thin layer of epithelial cells results in an unsightly cosmetic appearance *Delayed Suture* Pulling the wound together after a number of days produces more rapid healing but the final scar will be wider than that which follows first intention healing Of course a wide scar can later be excised and the skin margins reapproximated more precisely

the unhealed chronic wound may be undermined and drawn together to facilitate and accelerate healing

TYPES OF INCISIONS AND WOUND CLOSURE

Much has been written regarding what incisions and what types of suture material are to be preferred for particular surgical procedures Too often the author has had a personal preference that he wished to vindicate

Types of Incisions (Fig 9) There are a few incisions that under certain circumstances are attended by less risks of dehiscence than are others For example, a transverse muscle splitting incision in the

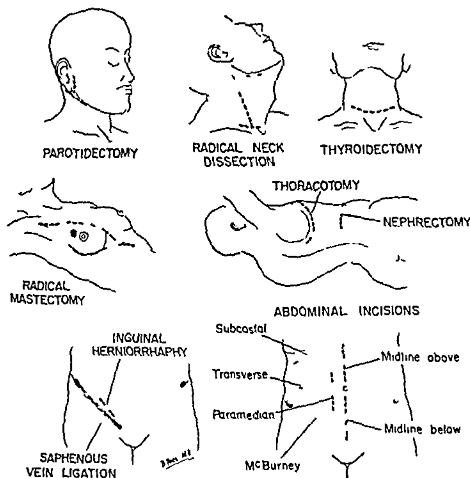


Fig 9—These incisions should be considered as representative only for wounds heal regardless of position Adequate exposure for the procedure contemplated should be secured but the incision should not be longer than required (as for liver biopsy where carcinomatosis with ascites exists)

right upper quadrant of the infant is to be preferred to the right paramedian incision for pyloromyotomy And the McBurney muscle-splitting incision for appendectomy is associated with fewer eviscerations and hernias than is a paramedian incision, especially in the presence of suppuration and bowel distention

Generally speaking however, there is no marked difference between the number of separations and hernias that follow transverse as compared with vertical incisions It is the care with which the wound is closed, plus other factors to be mentioned, that determines whether or not a wound separation will occur

It is obvious, of course, that the incision should be properly placed to permit the technical procedure that is planned Furthermore, while the incision should be adequate to permit satisfactory exposure, it should not be longer than is required for the surgery contemplated Separation is rarely a problem in short wounds One often sees the operator continue to extend the incision upward and downward when the presence of carcinomatous seeding on peritoneal surfaces or metastasis in the liver has already rendered curative resection impossible Just as common an error is an incision that is far larger than is required for the operation planned Such incisions are often explained on the basis of the dictum that a generous incision is required for adequate exposure and that " the wound heals from side to side and not from end to end " Yet, when long incisions are made in the abdomen of the patient with ascites, bowel distention, far advanced malignancy or peritonitis, one must be prepared to accept a much greater risk of wound disruption than when a diagnostic biopsy of metastases in the omentum or liver, supported by further palpation with one hand, was achieved through a short incision

Again the incision should be long enough to allow all maneuvers that are dictated by the clinical circumstances, but it should be no longer

Finally the surgical resident is apt to develop a certain reverence for time honored *incisions assuming that unique or unusual incisions* may, somehow fail to heal This is not true The tissues of the body surfaces will heal in any direction Of course, the lines of Langer should be respected in that the incision should follow the natural creases of the skin when this is readily applicable Moreover, one should not cross the axilla, else contracture may result

Nevertheless, the variety of incisions used for exposure of the great vessels of the mediastinum, as well as the thoraco abdominal incisions for other purposes, have convincingly established that wounds heal wherever they are Finally, neatly made incisions facilitate a neat repair

Types of Wound Closure As with incisions, the types of repair used for the closure of wounds are less important in preventing disruption than are certain other factors, provided, of course, that the repair is adequate with the suture material employed For example, within the same teaching hospital the surgeons of one service may close the fascia of most wounds with chromic catgut, those of a second service may use stainless steel wire and those of a third service may use silk And yet all three will achieve satisfactory wound healing with no significant differences in the incidence of early wound dehiscence and late hernia formation

Nevertheless, there are several points that are important, whatever the type of suture material and the method of suture placement First, the strength of the suture material must be adequate Most of us have heard silk sutures snap during the straining of the patient in the recovery room postoperatively Often the patient himself may announce that he felt the sutures tear loose The writer once saw 00 silk snap when a patient under spinal anesthesia retched during the repair of an inguinal hernia This is not to say, of course, that this suture material is not heavy enough for closure under many circumstances In that muscular young man, however, it was inadequate

A second matter of importance is that the sutures include sufficient depth of the two margins to be approximated and that they be placed at the proper intervals Needless to say, careful approximation of the layers of the wound presupposes adequate retraction and visualization to permit accurate and precise suture placement

Continuous sutures (FIG 10) heal satisfactorily in most instances, but interrupted sutures are used by most surgeons for closing the fascial layers of the abdomen Continuous chromic catgut sutures are commonly used for the repair of thoracotomy incisions

WOUND COMPLICATIONS

Hematoma Formation One of the most frequent causes of a prolonged morbidity due to the wound itself is hematoma formation

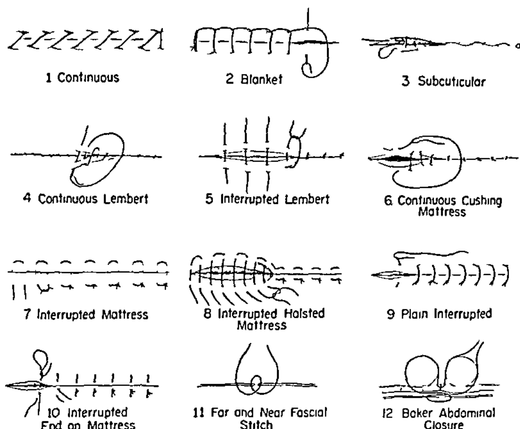


Fig 10—*Types of Sutures* (From Allen J G Harkins H N Moyer C A and Rhoads J E Surgery—Principles and Practice Philadelphia J B Lippincott Co 1957)

This is usually the result of inadequate hemostasis at surgery There is no substitute for meticulous hemostasis at the time of wound closure Of course a firm pressure dressing will control the flow of blood from between the skin sutures in many instances, but in some patients blood will collect beneath the skin At first this is manifested only by swelling and induration in the wound, but sooner or later it will be apparent that healing is less than optimal Old blood may escape after the skin sutures have been removed, or one may be forced to open the wound to drain the hematoma In any event the morbidity has been prolonged and the cosmetic result may be less than satisfactory If the incision has been made merely for the excision of a sebaceous cyst or for a breast biopsy under local anesthesia then the revisits to the office required by the hematoma and delayed healing will be a conspicuous nuisance to all concerned

Whereas some liquefied hematomas can be aspirated with a syringe

and needle (especially the late serosanguinous fluid beneath breast and thyroid incisions) many of them will require that the wound be opened with a hemostat

Wound Infections Suppuration within the wound may occur independent of hematoma formation, but very often the infection develops in a hematoma The collection of blood is an excellent culture medium

The first signs of a wound infection are pain, tenderness, induration, and increased warmth locally often associated with fever systemically After the first 24 hours wounds that are healing normally are not spontaneously painful particularly indurated or unduly tender to palpation

The management of an infected wound is to apply moist heat and allow the site of infection to manifest its location in the wound, at which time it is easily drained (FIG 11) This is far preferable to indiscriminate and blind "probing" of the healing wound

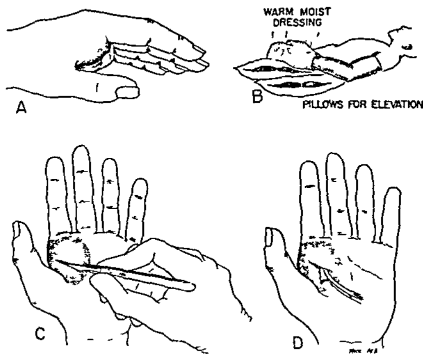


FIG 11—*Hand Infections* There has been so much discussion about the proper incisions for hand infections that the younger physician is unduly concerned lest he may make some serious mistake The most common serious mistake is to procrastinate hoping that surgical drainage of pus can be avoided with warm soaks and antibiotics If one incises the skin with a scalpel and then spreads gently with a hemostat until the pus is reached nerves tendons and arteries will not be injured A soft rubber dam drain is inserted to keep the wound open and soaks are continued thereafter

Occasionally one may wish to aspirate for pus with a syringe and needle, if pus is obtained, the wound is formally drained at that point and packed open temporarily If an infected wound is merely opened but no packing or drain is inserted to keep the margins of the wound separated, the margins may quickly seal over again and pus may reaccumulate beneath the skin, requiring a second drainage Warm "sterile" soaks are continued, even after surgical drainage, to accelerate wound cleansing

Antibiotic therapy, which should be used prophylactically only when a wound is contaminated, may suppress the development of an infection until antibiotics have been discontinued The patient may have been discharged from the hospital, only to return with an obvious wound infection Furthermore, the use of massive antibiotic therapy can so alter the clinical picture associated with large purulent collections that the patient's general condition may have seriously deteriorated before the diagnosis is made and surgical drainage has been accomplished Fever, particularly, is often mild under such circumstances

Wound Separation (Disruption Dehiscence) and Hernia Formation

Regardless of how abdominal wounds are closed some will disrupt in a few patients Assuming that the wound has been carefully closed in layers with a suture material of adequate strength, why does the occasional wound separate?

Local Factors in Wound Healing and Disruption Granted that suture material of adequate strength has been used, it is important to avoid hematoma formation tissue necrosis and infection Blood supply to the fascia can be seriously reduced by indiscriminate clamping of the tissue to be sutured, by the removal of fat and supporting tissue with blood vessels where this is not necessary, and by the strangulation of tissue with multiple tightly tied sutures In respect to blood supply following the resection of aneurysms of the abdominal aorta there is an unusually high incidence of wound separation with evisceration or late hernia formation This would seem to be due to first the length of the incision extending from the xiphoid process to the symphysis pubis and, second, a possible relative ischemia due to ligation of the lumbar arteries

Other important factors in abdominal wound separation are those which increase tension on the wound Patients who *cough* or *vomit,*

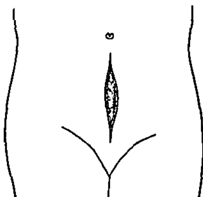
have *hiccups*, become *distended* with fluid or gas, or must be *bronchoscoped* are especially likely to be among those who have wound disruption

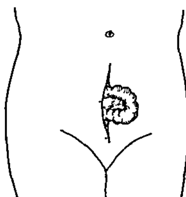
General Factors in Wound Healing and Wound Disruption It is less easy to pinpoint the specific metabolic lesions which are most apt to be associated with wound separation Certainly the general factors are far less important than the local factors Conditions which are usually considered to predispose to poor wound healing are hypoproteinemia (which reflects poor general nutrition), far advanced malignancy, poorly controlled diabetes mellitus and hyperadrenocorticism

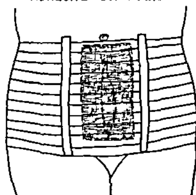
Management of Wound Disruption

Too frequently the first detection of wound separation (FIG 12) is made when omentum or a loop of bowel presents between sutures, if these have not been removed There frequently is a strong warning of impending evisceration, however, that is manifested by profuse serous or serosanguinous drainage from the wound Even though the skin sutures may have preserved approximation of the skin edges, this drainage indicates that the all-important peritoneal and fascial layers may have separated, leaving only the sutured skin to prevent actual evisceration At this point a decision as to management has to be made If the condition of the patient is so critical that further anesthesia for the placement of through and through heavy wire sutures may be fatal, one can apply wide adhesive tape transversely across the vertical incision This tape should extend to each flank laterally, and it should be applied in such a way as to relieve all tension on the wound margins With such strapping one hopes to prevent actual evisceration and to escape with only a ventral hernia that can be repaired later at an elective operation This course of action is effective in a good many patients when complete wound separation and evisceration have not occurred However, in some patients the skin wound will also separate despite the adhesive strapping, and prompt closure under anesthesia is required

In the husky adult of good general health, one need have no hesitation in promptly using adequate anesthesia to close a defective wound adequately For years it was often stated that the mortality in patients who sustained wound dehiscence with evisceration was great, even up to 70 per cent However, personal experience







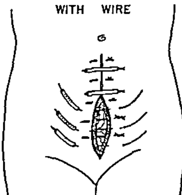


FIG 12—*Wound Dehiscence* Partial wound separation may be treated conservatively If a hernia develops it can be repaired later However since partial separation may progress to frank evisceration prophylactic adhesive strapping is often employed The tape is applied in such a way as to approximate the wound margins and to avoid tension in the mid line Evisceration usually requires formal closure of the wound with stainless steel wire passed through all layers Between the wire sutures the skin is approximated with vertical mattress sutures of silk

has convinced the writer that this impression is erroneous, at least in present-day surgery Most patients who are in reasonably good general condition do surprisingly well when adequately supported with blood transfusion and the proper anesthesia for secondary wound closure Certainly our mortality resulting from, or associated with, this complication has been gratifyingly low

Partial wound separation may result in intestinal obstruction due to incarceration of a loop of small bowel

Management of Wound Evisceration Evisceration requires re-

parative surgery. In general one covers the exposed bowel or omentum with a sterile dressing and securely applied adhesive tape until the operating room and blood for transfusion are ready. Then adequate anesthesia is employed to permit the placement of heavy through and through stainless steel wire sutures. This type of closure entails the passage of the sutures through all layers of the abdominal wall (peritoneum, fascia and skin) well back from the margins. The sutures are loosened from time to time in subsequent days, but they are usually allowed to remain for almost three weeks.

It is most important not to include a loop of bowel in one of the wire sutures, and it is also important not to leave a suture so loose that a loop of small bowel can later slip between it and the abdominal wall to produce intestinal obstruction.

Thoracotomy Wounds. Impending separation of a thoracotomy incision may be reflected in the development of paradoxical motion due to separation of the ribs and muscle beneath the skin. Here too there may be the warning profuse serous or serosanguinous drainage.

MANAGEMENT OF TRAUMATIC WOUNDS

The wound inflicted by gunshot or other types of violence differs in many important respects from the simple incision made by the surgeon at laparotomy. To begin with, the missile may have gone in any direction and its pathway is often marked by necrotic muscle, fractures and severed nerves and blood vessels in the case of an extremity injury. If the missile has entered a coelomic cavity any viscus may have been damaged (pp. 70–74).

Extremity Injuries. Preoperatively one should first resuscitate the patient if he is in *shock*. This consists primarily of blood transfusion and stopping further bleeding. Next, a careful *physical examination* should be made and the specific status of nerve activity and arterial pulsations recorded. For example, it is not uncommon for a patient to have complete motor and sensory functions on admission only to lose them later. When this occurs one can feel reasonably certain that the neighboring tissue reaction and edema have only impaired nerve function and that function will presently return, often in days or weeks. If impaired nerve function is present on admission, actual nerve damage is likely. Nerve deficits are especially likely to be overlooked in inebriated patients since a careful neurological examination is often impossible.

While absent popliteal and foot pulses associated with a thigh wound may be due merely to arteriospasm, it would be unwise to assume that this is so without excluding the possibility of arterial damage A femoral arteriogram may reveal an occlusion or division of the vessel Or, if operative debridement is to be performed (as it often will be), formal exposure of the artery can be carried out at that time, if indicated Anastomosis of the debrided ends of the severed artery is almost uniformly successful

After resuscitation and physical examination have been completed a *roentgenogram* of the extremity should be taken to exclude fractures and to identify the presence of radiopaque bullets, birdshot or knife parts Thereafter, the patient is transported promptly to the operating room, and under appropriate anesthesia the extremity wound is meticulously debrided through a liberal incision A pneumatic tourniquet that can be inflated if necessary to control brisk arterial bleeding is useful The preparation of the operative site should include vigorous scrubbing with a brush and copious amounts of soap and water Necrotic skin and subcutaneous tissue are removed, damaged muscle is ruthlessly excised, until fresh bleeding occurs from the remaining healthy muscle Finally, the nerves and the principal artery (brachial or femoral) are exposed and repaired as necessary If the wound is a fresh one, the nerves are repaired at once If many hours have elapsed, the artery should be sutured but the nerve ends in a contaminated wound should be tagged with black silk (readily found on reoperation) or wire (radiopaque) sutures to be picked up weeks later when danger of infection has passed (Regeneration of a sutured nerve is often defective) Following further profuse irrigation of the debrided wound with saline solution adequate drains are placed and the wound is closed loosely around them Fractures are managed as indicated

Prophylactic tetanus antitoxin or toxoid booster should be administered

WOUND DRESSING (FIGS 13–15)

Much of the surgical house officer s daily activity centers around the dressing of wounds (FIG 13) Each hospital has its more or less established routine and only a few comments and suggestions will be emphasized here (1) A definite scheduled time will assist the nursing personnel in keeping the dressing cart (FIG 14) well stocked

ILLUSTRATIVE DRESSINGS

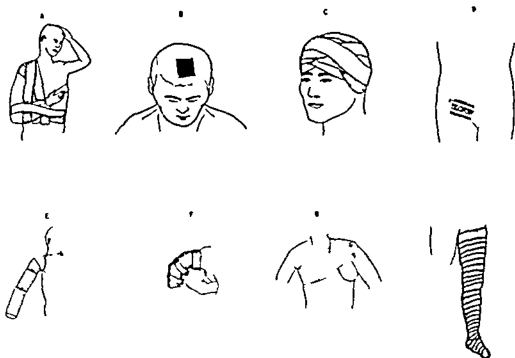


FIG 13—(A) Supportive dressing for shoulder and arm The hand may rest more comfortably in a sling (B) Gauze and collodin dressing for scalp This permits the application of the dressing with minimal hair removal The scalp has a rich blood supply and wounds do not often become infected (C) Head dressing for general purposes including craniotomy and mastoid wounds The ears may be exposed if desired A properly applied bandage can be surprisingly secure (D) Minimal dressing over simple abdominal incision (E) The arm may be wrapped with warm moist dressings and cellophane or other plastic then applied to keep the bed clothes dry (F) As a rule the finger is placed in a position of moderate flexion A hairpin may be incorporated in the dressing for rigid immobilization (G) Dressing for wounds involving the axilla or shoulder area (H) Elastic bandage applied upward from toes to groin

with tape, sterile dressings, drains, suture removal sets and numerous other items which on occasion are needed Few efforts waste more of the resident's time than attempting to dress the wound using a cart depleted of most of the usual essentials (2) There is an increasing tendency to use fewer dressings on clean wounds In fact many surgeons use no dressings A sterile towel is laid over the sutured incision for approximately an hour, thereafter, the sutures and the incision are exposed Although I still use dressings with my own patients, many of my colleagues do not and have no greater

Fig 14—The dressing cart should be fully restocked at a *specified* time during each 24 hours

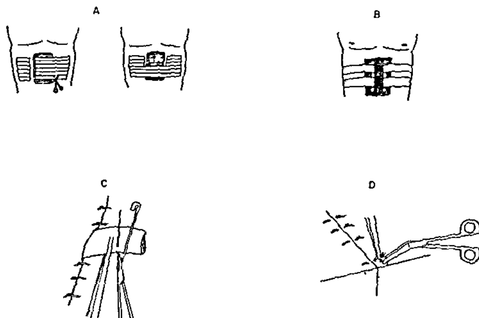


Fig 15—(A) When a wound *is to* be re-dressed the tape may be cut on either side *to spare the patient the discomfort of having adhesive tape removed unneces* sarily (B) When the dressings over a wound must be changed frequently, *e g* with excessive drainage of some *type* Montgomery straps should be prepared In essence the wide adhesive tape is *passed around* two tongue blades medially which are held together over the dressing by *easily* removed rubber bands (C) The technic of shortening a drain with *instruments (D)* The removal of skin sutures

incidence of wound infections In any event, much waste can be avoided by using no more dressings and tape than actually required (3) A clean wound without drains does not usually require dressing until time for removal of the sutures However, if the dressing is soiled or has an odor, if the wound is unduly painful, or if the patient wants the wound dressed—any of these circumstances may prompt re dressing (4) If a wound is to be re-dressed one should cut the tape on either side, as shown in FIGURE 15 In this way the tape is never pulled off until it is no longer needed (5) If repeated dressing will be required Montgomery straps (FIG 15) should be used (6) It is usually preferable first to cut all sutures to be removed, and then to withdraw them rapidly This results in less psychic trauma in some subjects (7) The use of subcuticular silk or cotton sutures will preclude the need for removal of skin sutures in the early post-operative period but these sutures have a tendency to be extruded periodically in subsequent months The use of subcuticular catgut avoids this

REFERENCE

1 HOWES E L SOOY J W AND HARVEY S C The healing of wounds as determined by their tensile strength J.A.M.A. *92* 42 1929

7 Routine, Preoperative and Postoperative Orders

THE NEW INTERN frequently has some apprehension concerning how to "write orders" especially for surgical patients where formal cognizance must be taken of the coming operation (*Preoperative Orders*) and the early period after surgery (*Postoperative Orders*)

ROUTINE ORDERS

When a patient is admitted to the hospital certain routine orders are required even if the patient is in only for study These orders might include the following

(1) Diet—general or special
(2) Ambulatory? Bed rest with bath room privileges? Or strict bed rest?
(3) Laxative if desired
(4) Aspirin for pain p r n
(5) Sedative for sleep if required (e g secobarbital 100 mg P O)
(6) Request urinalysis blood count and serology

Other orders are often added to fit individual cases and to prepare the patient for special studies such as the B M R , barium enema or cholecystogram However, the preparation for various roentgen studies varies in different hospitals and the intern is advised to consult the manual of procedures compiled by the several services in his particular hospital He may also ask the head nurse what special measures are required

PREOPERATIVE ORDERS

Whatever orders may currently be in force the term *Preoperative Orders* cancels all orders except those written below this phrase Therefore even if the patient has been receiving digitalis, insulin or hydrocortisone he should not receive any drug in the future unless it is written with the preoperative orders Similarly, the phrase *Postoperative Orders* cancels the preoperative orders Preoperative orders can represent an absolute minimum as follows

Preoperative Orders

(1) *Nothing by mouth.* (To avoid vomiting during anesthesia with the risk of aspiration of vomitus into the lungs. When aspiration occurs the patient may die immediately from suffocation due to drowning or pneumonitis or lung abscess may develop later.)
(2) *Secobarbital or pentobarbital I.M.* in appropriate dosage (TABLE 10). (To allay anxiety and reduce the incidence of cardiac arrhythmias. Morphine depresses respiration and should not be used unless pain exists preoperatively.)
(3) *Atropine I.M.* in appropriate dosage. (To reduce the secretions in the oropharynx and tracheobronchial tree.)
(4) *Prep (shave) operative area.*
(5) *Have patient void* before going to surgery. (To improve exposure in the pelvis and to avoid undue bladder distention during and following operation.)

Thus, if the stomach is empty and atropine has been given, appendectomy can be performed as soon as the abdomen has been shaved and the patient is anesthetized. In marked contrast, the preparation required for the performance of an open heart operation is detailed, specialized and far reaching. It involves the patient, operating room, special equipment such as the pump-oxygenator and numerous members of the operating and supporting teams. Yet the orders that are required for special procedures can always be asked of the resident on the service. The routine preoperative enema, such a ritual a decade ago, has been largely abandoned except where colon or other pelvic surgery is facilitated by an empty lower bowel. It is essential to have adequate blood crossmatched in the bank to take care of any contingency that the particular operation in question may occasion. Average requirements are indicated in TABLE 8.

POSTOPERATIVE ORDERS

The postoperative orders should be written before the patient leaves the operating room; otherwise, some member of the operating team will have to go to the recovery ward or to the floor to write them so that the nurses can begin postoperative management. Such orders usually include the following:

Postoperative Orders

(1) *Vital signs.* Take pulse rate, respiratory rate and blood pressure every 15 minutes for 2 hours, then every 30 minutes for 4 hours, then every hour for 12 hours or longer if blood pressure has not stabilized. Take the rectal temperature every 2 hours. (The importance of frequent checking of these vital signs in the early postoperative period lies not only in their importance *per se*, in having to take these measurements so that they can be recorded on

TABLE 10*—*Average Dosages of Commonly Used Drugs (Adults)*

Agent	Dosages		
	Orally	*Intramuscularly*	*Intravenously*
Aminophylline	0.1–0.48 Gm. t.i.d. (may be given rectally)	0.48 Gm.	0.24–0.48 Gm. given slowly
Atropine Sulfate	0.32–0.65 mg.	0.32–0.65 mg.	
Banthine	50 or 100 mg./6 hrs.	50 mg. q. 6 hrs.	
Calcium Gluconate	1–5 Gm. t.i.d.	5 cc.–10 cc. 10% solution	10 cc. 10% solution
Chlorpromazine (may produce hypotension)	Varies—initial dose 25–50 mg./6 hrs.	Varies—initial dose 25–50 mg./6 hrs.	
Codeine	30–60 mg. q. 4 hrs. (may use with 0.3–0.6 Gm. aspirin) p.r.n.	60 mg. q. 4 hrs. p.r.n.	
Demerol (Meperidine)	50–100 mg. q. 4 hrs. p.r.n.	50–100 mg. q. 4 hrs. p.r.n. (Start with conservative dosage)	
Dicumarol (follow the prothrombin level)	300 mg. 1st day 200 mg. 2nd day 100 mg. 3rd day		
Dramamine	50 mg. q.i.d. (may give rectally)	50 mg. q. 4 hrs.	
Epinephrine (avoid overdosage)		0.06–1 cc. of 1:1000 solution	
Heparin (follow the clotting time)		50 mg./6 hrs.	
Hydrocortisone (dosage varies with circumstance)	12.5–100 mg. q. 6 hrs. or q. 12 hrs. or q. day		Postoperatively 100 mg. q. 6 hrs. at slow drip
Kaopectate	2 tbsp. t.i.d.		
Metamucil	1 tsp. 1–3 times daily		
Morphine Sulfate (avoid overdosage especially in aged and (?) in liver disease)		10 mg. < or > as needed	Same given slowly
Paregoric	1 tsp. repeat in 4 hrs.		
Pentobarbital	0.1–0.2 Gm. repeat once p.r.n.	0.1–0.25 Gm.	0.1–0.25 Gm. in 5% solution
Pitressin		0.25–0.5 cc. repeat at 3–4 hr. intervals p.r.n.	

TABLE 10—*Continued*

Agent	Dosages		
	Orally	Intramuscularly	Intravenously
Potassium Iodide (or Lugol's) Solution	10 drops t i d		
Priscoline	50 mg 5 6 times daily	10 50 mg q i d	10-50 mg q i d
Probanthine	1 tablet with meals 2 at bedtime (15 mg /tablet)	30 mg /1 cc H_2O	30 mg /1 cc H_2O
Propylthiouracil	300 800 mg daily in divided doses		
Protamine (to counteract heparin)			mg for mg (of heparin)
Scopolamine	0 5 mg -1 1 mg		0 5 mg
Secobarbital	0 1 Gm to 0 20 Gm	100-150 mg	100-150 mg
Telepaque Tablets	6-12 tablets (1 @ a time) with water		
Vitamin A	25 000 u s p units or more daily	50 000 u s p units as required	
Vitamin B Complex	Dosage as indicated for each preparation		
Vitamin K	10 20 mg	10-20 mg	
Vitamin K_1 Oxide (to counteract dicumarol)			100-500 mg at slow drip

(Modified from Modern Drug Encyclopedia and Therapeutic Index Ed 6 Howard M D ed New York Drug Publications Inc 1955)

the chart for the inspection of all the nurse will inevitably note the mental status of the individual whether the intravenous is running dry whether excessive bleeding is coming from the wound or whether the catheter nasogastric tube or T tube is functioning properly whether the patient is vomiting etc)

(2) *Intravenous fluids (representative)*
  (a) Finish bottle of blood that is now running
  (b) 500 cc isotonic saline in 5 per cent glucose
  (c) 1000 cc 5 per cent glucose in water
(3) *Intake output record*
(4) *Analgesic* (usually morphine or demerol in proper dosage)
(5) *Turn patient frequently and urge coughing and deep breathing Aspirate nasopharynx if required*
(6) *Bed patient until fully reacted May later stand to void Up tomorrow*
(7) *Call intern if patient is unable to void after 12 hours* (Intern may stand the patient up or have him try to void while sitting on the commode or by placing the penis in warm water and running water from the faucet etc

TABLE 11—*Antibiotics Agents and Dosages*

Agent	Dosages		
	Orally	Intramuscularly	Intravenously
Chloramphenicol (Chloromycetin)	50-75 mg /kg initially then 0 25-0 5 Gm q 2-3 hrs	1 Gm q 8-12 hrs	
Chlortetracycline (Aureomycin)	1 Gm /day in 4 equal doses	100 mg q 8-12 hrs	500 mg q 12 hrs
Combiotic		400 000 units procaine penicillin G & 0 5 Gm dihydrostreptomycin sulfate/cc Give 0 5-1 0 cc q 12 hrs	
Dihydrostreptomycin		1 0 Gm q d 3 × weekly for 3-6 mos (for tbc)	
Erythromycin (Ilotycin)	250 mg q 6 hrs		250-500 mg q 6 hrs
Furadantin	5-10 mg /kg /24 hrs in 4 divided doses		
Gantrisin	3-4 Gm initially then 1 Gm q 6 hrs		
Neomycin	1 Gm q hr for 4 hrs then 1 Gm q 4 hrs for 24-72 hrs preoperatively	10-15 mg /kg up to 1 Gm /day in 4 equal doses at 6 hr intervals	
Oxytetracycline (Terramycin)	1-4 Gm /day in 4 equal doses at 6 hr intervals	0 2-0 3 Gm /day in 0 1 Gm injections at 8-12 hr intervals	0 5-1 0 Gm /day in divided doses at 12 hr intervals
Penicillin (Dosage varies with clinical circumstances)	Usually somewhat higher than dosage I M	Aie 1 cc q 12 hrs for 5-10 days (300 000 units/cc)	30 mil or more units/day for septicemia (Use catheter in vena cava)
Polymyxin B	Parenteral use only		
Streptomycin	(For bowel) 0 5 Gm q i d for 3 days	0 5 Gm - 2 0 Gms or more/day	
Sulfadiazine	4 Gms initially then 1 Gm q 6 hrs		
Sulfasuxidine	0 25 Gm /kg initially then 1/6 initial dose q 4 hrs		
Tetracycline (Achromycin)	1 Gm /day in 4 equal doses	100 Gm q 8-12 hrs	500 mg q 12 hrs

If catheterization is required a second time a Foley catheter should perhaps be left in place until the patient is truly ambulatory)

(8) *Antibiotics** (TABLE 11)

(9) *Connect various tubes to appropriate receptacles* (*e g* nasogastric tube

to continuous suction indwelling urethral catheter to drainage bottle T tube to drainage bottle or chest tubes to underwater closed drainage)

Again, special operations require special measures, but these will be noted in connection with consideration of these operations elsewhere in this volume The orders given above will apply to the large majority of patients who have just had major surgery

ORDERS REWRITTEN

It is an excellent practice to re-evaluate periodically all orders that the patient is getting The ones no longer needed are discarded, antibiotics and morphine especially may be discontinued The phrase *Orders Rewritten* is then written on the order sheet and the few remaining orders that are to be continued are listed below it This bit of service housekeeping results in assistance to the patient, the nurses and the physicians in charge Each member of the hospital staff can now see at a glance what orders are in effect

8 Trauma and Burn Management

TRAUMA

THERE ARE CERTAIN STEPS which are generally followed on surgical services where trauma cases are frequently managed Some of the more important of these will be now listed, with appropriate comment Let us assume that a patient who has sustained multiple 38 caliber bullet wounds possibly involving the head, chest, abdomen and extremities has just been brought into the emergency room What steps are indicated, and in what order (FIG 16)?

(1) *Check vital signs* Shock may be due to various causes including defective pulmonary ventilation simple blood loss or gross peritoneal contamination with colonic contents (TABLE 12) However the immediate requirement is to resuscitate the patient to preserve life while accurate diagnosis of the extent of the injuries is being carried forward

(2) *Oxygen therapy* by nasal catheter to promote oxygenation of the tissues Laryngoscope needed (FIG 17)?

(3) *Intravenous infusion* first of a plasma expander (or lacking this even isotonic saline) and then of blood as soon as it can be cross matched

(4) *Check pulmonary ventilation* by inspection percussion and auscultation of the chest If serious respiratory distress exists tap the chest (thoracentesis) on the involved side to remove blood and/or air If pneumothorax continues insert intercostal catheter with under water drainage (FIG 28) *Tracheostomy* (FIG 18) will not usually be required unless there are wounds involving the mouth

(5) *Stabilize fractures* with a splint temporarily

(6) *Complete the physical examination* Having assured effective pulmonary ventilation and an adequate circulating blood volume as reflected in a rise in the blood pressure from shock levels a very careful physical examination is next in order to identify precisely what the requirements of further management are likely to be

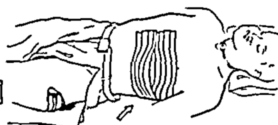
(a) *Head* Is there evidence of head injury? If so proper consultation is requested

(b) *Chest* The previous evaluation of possible chest injury will be supplemented by a chest x ray *Pericardial tamponade* is to be suspected when a narrowed pulse pressure is associated with distention of the neck veins pulsus paradoxus and diminished cardiac pulsations on fluoroscopy If there is a strong possibility of tamponade (as judged from the location of the injury and the clinical findings) it is far better to risk an unnecessary pericardiocentesis than to allow the condition of a critically ill patient further to deteriorate during attempts at diagnostic fluoroscopy The insertion of the needle just to the left of the xiphoid at a 45 degree angle to the supine patient, con

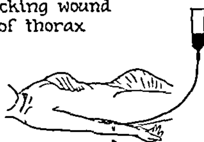


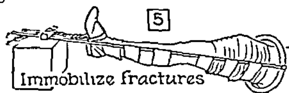












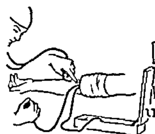


Fig 16—*Priority in the Management of Trauma* The degree of physiologic urgency represented by each of the several different types of injury is acknowledged in outlining total management (From Hampton O P Jr and Fitts W T Jr Fractures and dislocations general consideration *In* Allen J G Harkins H N Moyer C A and Rhoads J E Surgery—Principles and Practice Philadelphia J B Lippincott Co 1957)

TABLE 12—*Causes of Shock Following Trauma*

1 INTRACRANIAL INJURY
   a Hemorrhage
   b Contusion
   c Depressed fracture
2 THORACIC INJURY
   a Hemothorax
   b Pneumothorax
   c Paradoxical motion of chest wall with inadequate pulmonary ventilation
   d Bronchial tear
   e Pulmonary edema
   f Cardiac injury and/or pericardial tamponade
3 INTRA ABDOMINAL INJURY
   a Hemorrhage
   b Massive intraperitoneal and retroperitoneal effusion as with certain fractures of the pelvis
   c Infection from perforated viscus
4 EXTREMITY INJURY
   a Hemorrhage
   b Massive wound edema
   c Extensive muscle trauma
   d Multiple long bone fractures

stitutes a very satisfactory approach Again intrapleural blood and/or air is aspirated if aspiration must be repeated more than twice, we usually insert an intercostal catheter (FIG 28) If multiple fractures of adjacent ribs have resulted in a *flail chest* (FIG 24) with paradoxical motion of the chest wall (common in car accidents but uncommon in bullet injuries) temporary stabilization can be achieved by adhesive strapping *Later this* can be replaced by rib or soft tissue traction to avoid having the fractured ribs heal in a depressed position with reduced lung volume A *sucking wound* of the chest is temporarily managed by the application of petrolatum gauze covered with dressings and adhesive tape Later the wound can be debrided and formally closed in the operating room The petrolatum gauze

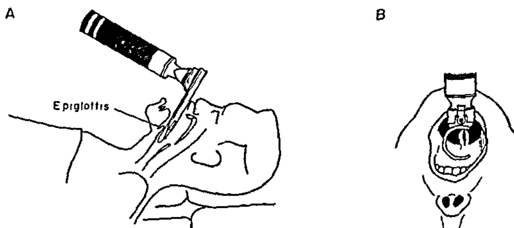


FIG 17—All surgeons should gain experience in the use of the laryngoscope For example it is of value in the presence of anesthetic difficulties in respiratory obstruction in coma for tracheal suction in infants and for visualizing the vocal cords at the close of a total thyroidectomy or radical neck dissection The first important maneuver is (A) to pass the blade posterior to the epiglottis and lift it anteriorly This will bring the cords into view (B) All movements should be gentle but deliberate As the scope is passed the head should be hyperextended

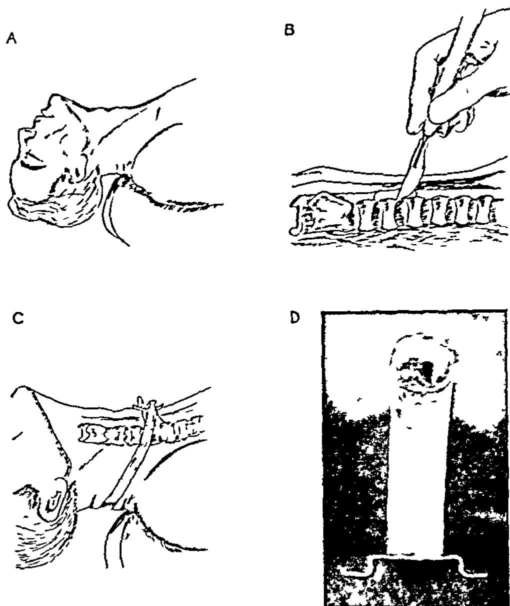


FIG 18—*Tracheostomy* is now frequently employed It should be resorted to in most patients who have serious laryngeal obstruction and it should be performed before the patient has become comatose from asphyxia which threatens imminent cardiac arrest Under local anesthesia with the neck hyperextended (A) the trachea is exposed through either a vertical or preferably a transverse skin incision A vertical incision (B) is made through 2 or if necessary 3 tracheal rings at a level about 3 rings below the cricoid cartilage A portion of two cartilages is excised anteriorly to permit the ready insertion of the tracheotomy tube (C) If one stays in the mid line only venous bleeding will be met and this is rarely excessive The isthmus of the thyroid is retracted upward or occasionally partially divided The overriding objective in the emergency is to establish an opening into the trachea quickly but later care is important Shown here (D) is a tube removed from the neck of a patient who was near asphyxiation Note that the tube had been allowed to become completely plugged with inspissated secretions leaving almost no tracheal lumen remaining for pulmonary ventilation

should be applied at the end of a forced expiration to minimize the volume of air trapped in the pleural space Even if the x ray reveals a bullet in the chest *emergency thoracotomy* is not often required in such circumstances Pulmonary bleeding and air leaks usually cease spontaneously, though intercostal or internal mammary artery injuries often will not do so Patients with major aortic or other great vessel injuries may not live to reach the hospital With shotgun injuries thoracotomy may be required to remove wadding and devitalized lung tissue

(c) *Abdomen (including diaphragm)* The chest injuries were considered first because cardiopulmonary function is essential to life Those which involve the abdominal viscera can be just as fatal but usually not as rapidly Abdominal injuries may result in hemorrhage (liver spleen mesentery etc) or peritonitis from perforation of hollow viscera or the urinary tract Bleeding of significant degree will be reflected in the usual signs of concealed hemorrhage such as a shock like state associated with a declining hematocrit Peritoneal contamination may or may not produce abdominal pain tenderness and rigidity (Particularly retroperitoneal gastric duodenal or colonic leakage may result in few early signs) In general most bullet wounds of the abdomen must be explored to rule out perforation of a viscus Confirmatory evidence of visceral injury may consist of (1) blood in the gloved finger at rectal examination (2) blood in material aspirated from stomach (3) hematuria or (4) free air in the peritoneal cavity on roentgen examination

(d) *Extremities* It was stated previously that the arterial pulsations sensation and motor power and the possibility of fractures should be determined promptly and the findings written down Often a pulse may reappear when it was formerly absent perhaps indicating that arterial spasm existed previously Motor power present on admission may later diminish indicating that the nerve has been damaged by contusion but has not been severed

(7) *Special Roentgen Studies* The routine films of the injured parts were mentioned above However special studies are often extremely valuable in trauma cases
   (a) *Bronchograms* to reveal bronchial injury
   (b) *Esophagram* to identify esophageal perforation
   (c) *Urogram* or *cystogram* to rule out urinary extravasation due to kidney ureteral or bladder injury
   (d) *Arteriograms* of various vessels (*including head and lower extremity*) to demonstrate occlusion displacement or extravasation
   (e) *Gastrointestinal series and barium enema* are not often used unless a *diaphragmatic hernia* is suspected These organs are carefully inspected at laparotomy with the exception of the colon beneath the pelvic floor which is visualized on sigmoidoscopy

Summary

Once the measures outlined above have been methodically taken, plus any others required in special instances, it will usually be possible to proceed with orderly management To recapitulate, head injuries of significance require neurosurgical consultation, chest wounds by bullets can often be managed conservatively, although thoracentesis and at times closed (under water) thoracotomy tube

drainage may be necessary, abdominal wounds are wisely explored in most instances and extremity wounds are cared for on the basis of the muscle nerve, arterial or bone damage encountered Immediate and continued attention to resuscitation with measures to *maintain an adequate blood volume and pulmonary ventilation will* usually preserve life until anatomic and physiologic defects can be corrected

BURNS

The burn may be the result of electrical or thermal insult The latter is often classified according to whether the injury was a flash burn, a scald burn or a flame (house fires, clothing flames) burn *Of these three the flame burn is the one most likely to produce deep* third degree (requires grafting) injury

The prognosis in a given burn injury depends on the *surface area* involved (FIG 19) and the *depth* of the lesions To a lesser extent the *age* of the patient is important for a burn that would be considered relatively minor in a young person will often prove fatal in the elderly Therefore, it is well to take a conservative position when discussing with the family the prognosis of a patient who has a full-thickness flame burn involving 40 per cent of the body surface area Even if no major complications (gastrointestinal hemorrhage, massive infection, failure of grafts to take) develop, the recovery will require weeks or months Flame burns of full-thickness which involve more than 50 per cent of the body surface are usually fatal eventually

Physiologic Considerations

The severe burn produces large shifts in body fluids and electrolytes in addition to the destruction of a portion of the red cell mass Thus, the early therapeutic considerations are to combat "burn" shock by blood transfusion and the administration of enough saline solution to replace the extracellular losses into the *third space* beneath the burn wounds as *wound edema* In addition sedation, antibiotics, tetanus prophylaxis and the care of the burn wounds themselves must be considered

Treatment of 40 per cent Flame Burn in 60 Kg Man

(1) Check vital signs This is repeated at 30 minute intervals

(2) Intravenous fluids Begin isotonic saline or balanced electrolyte infusion (using the same needle and venipuncture employed for obtaining the blood

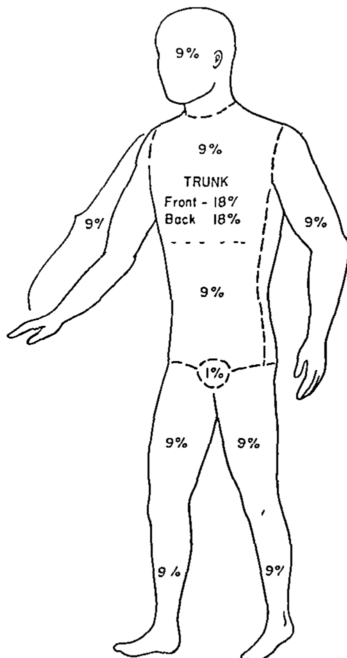


FIG 19—The *rule of nines* serves as a practical guide in the rapid estimation of the surface area burned

sample for cross-matching) A cut-down at the ankle may be required if the arms are burned

Total Fluids

First 24 Hours

Blood or plasma expander (% burn × body weight in kg) = 2100 cc

Isotonic saline or balanced electrolyte solution (% burn × body weight in kg) = 2100 cc

Glucose solution (5% in water) = 2000 cc

Total = 6800 cc

Second 24 Hours

Blood or plasma expander (½ amount given in first 24 hours) = 1200 cc

Isotonic saline or balanced electrolyte solution (½ amount given in first 24 hours) = 1200 cc

Glucose solution (½ amount given in first 24 hours) = 1000 cc

Total = 3400 cc

Thus during the first 24 hours approximately 7 liters of fluid should be given and one half of this (especially with respect to the colloid solution) should be infused in the first 6 hours of that period The volumes of the various solutions are simply cut in half for therapy during the second 24 hours The glucose solution is given to provide for urine formation If the patient is obese or elderly the estimated volumes should be revised downward In contrast the maintenance of an adequate blood pressure (which is checked every 30 minutes during the first 24 to 48 hours) may require even more fluid than has been outlined above Even so this formula of Evans has proved in our hands to be a generally reliable guide to dependable fluid therapy in the early management of the extensively burned subject After the first 48 hours the fluids must be administered on the basis of the frequent and continuous re-evaluation of the clinical condition of the patient assisted by plasma chemistry values Particularly important guides are the blood pressure and the urinary output Acidosis is treated with sodium bicarbonate solution

(3) Place patient in bed on sterile sheets One may elect to debride the burn wounds and then to dress them with fine mesh gauze impregnated with petrolatum this being covered with loosely applied gauze dressings The open or exposure method may be feasible especially if the patient has an unburned surface upon which he can lie However it is better to dress wounds that must come into contact with the bedclothes At times a combination of the closed and open methods can be used most effectively

The sterile sheets are no longer sterile when the patient lies on them but they avoid immediate contamination of the burn wounds with the hospital bacteria which are probably antibiotic resistant

(4) Tetanus prophylaxis is mandatory either by a booster dose of toxoid in the individual who has been actively immunized or with tetanus antitoxin (3000 units) in the subject not previously immunized

(5) Antibiotics may be given immediately or reserved until frank sepsis has developed Actually the value of their routine use is under reappraisal Up until the present time they have been given almost routinely but they have *not* prevented the development of infection in most extensively burned individuals However their great value in the treatment of proved septicemia by a susceptible microorganism cannot be denied Again in burn management as in all *other* phases of surgery the routine prophylactic use of antibiotics is under critical survey At this time we still use penicillin and *streptomycin* prophylactically in burns but our views are subject to modification if such practice is proved *to be unwise*

(6) *Sedation* Morphine or demerol is usually employed to control pain but often barbiturate suffices (The patient may be more apprehensive than in pain)

(7) Intake-output record The blood pressure and the rate of urine flow provide perhaps the *most* important objective criteria as to the adequacy of fluid

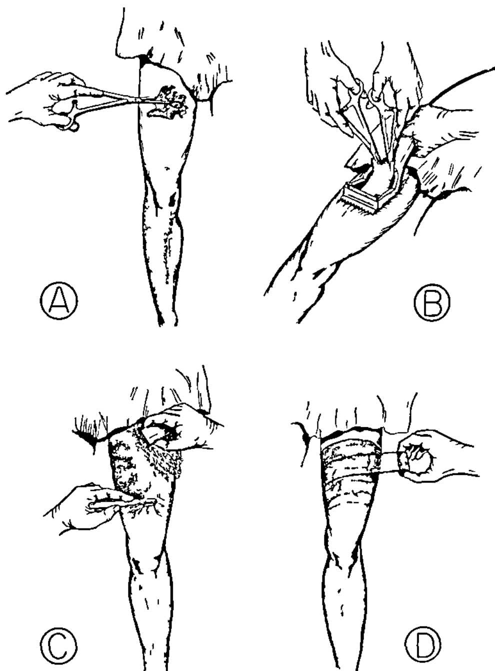


Fig 20—*Technic of Skin Grafting* (A) Preparation of donor site and final application of mineral oil (B) Cutting the split thickness graft ($^{10}/_{1000}$ to $^{20}/_{1000}$ of an inch in depth) with the electric dermatome (C) Preparation of the wound for grafting using sharp excision of remaining slough plus vigorous cleansing of the granulation tissue with saline soap and brush (D) The grafts have been applied transversely sutured together where necessary and fine mesh petrolatum impregnated gauze is being applied loosely in a circular manner The petrolatum dressings are not removed until from 5 to 7 days have elapsed by which time the takes have for the most part become adherent to the granulating bed of the wound and do not come away with the dressings

therapy in burns A careful intake record and an hourly measurement of urine flow are important to have

(8) The burn wounds themselves The open *versus* the closed management was mentioned above Debridement is limited to gentle soap and water cleansing and the excision of broken blisters Unruptured blisters (vesicles) are not opened for to do so results in the loss of more plasma and exposes the underlying skin elements to infection at an earlier date than would otherwise be the case

Summary

After the first few days, during which massive fluid shifts are proceeding apace with fluid retention and subsequent fluid excretion, other burn problems move into focus These are particularly concerned with adequate *nutritional maintenance*, *sepsis* beneath the burn eschars, *anemia*, and the depletive effects of extensive *skin grafting* (FIG 20) These problems must all be treated vigorously and effectively if the individual who has sustained an extensive flame burn is to survive

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9 *Some Operations Involving the Head and Neck*

THE PRECAUTIONS associated with operations on the neck are concerned especially with the fact that the functions of breathing and swallowing may be interfered with In addition, certain important *nerves may be injured through carelessness or necessity*

PAROTIDECTOMY FOR TUMOR

The special features of preoperative, operative and postoperative care in performing adenectomy, hemiparotidectomy or total parotidectomy for tumor are largely associated with preservation of the *facial nerve* and its branches in order to avoid facial weakness *In general one must be able to stimulate the branches of this nerve* as surgery proceeds, a small *battery-type electric stimulator* (Faradic current) is satisfactory

At operation the fascia overlying the gland is exposed by a Y-type incision that extends in front and behind the ear and forward toward the submaxillary gland As a rule, it is much more satisfactory to identify the facial nerve as it courses forward adjacent *to the styloid process than it is to locate the individual branches* anterior to the parotid gland As the nerve enters the gland it begins to give off numerous branches These are readily exposed and identified by frequent but not excessive stimulation, with the face and mouth exposed to view, under general anesthesia using an endotracheal tube

Occasionally, the extent of a parotid tumor or of some lesion *adjacent to the parotid is rendered more obvious by the injection* of *methylene blue* into Stenson's duct preoperatively The parotid gland will take on a bluish discoloration throughout its extent Tumors do not contain ducts and hence are not likely to be stained My personal experience with this technic has been limited to its use in 1 case, but I was much impressed by the vividness with which the boundaries of the parotid gland were defined

It is a wise policy to warn the patient that, following formal exposure and electrical stimulation of the facial nerve, there will likely be some *facial weakness* for a time postoperatively This occurs in many patients in whom the nerve has been carefully preserved The duration of the paresis is usually a matter of weeks, but at times months are required for normal function to be restored Of course, this complication might be taken as a contraindication to radical exposure of the gland and the nerve in removing "benign" parotid tumors but we cannot agree A parotid tumor is a vicious lesion because of its strong tendency to recur after inadequate excision The major cause of recurrence is that, due to apprehension concerning the facial nerve the operator attempts to "shell out" a tumor that often has fine projections that are divided, not excised At a second operation performed through scar tissue, it is much more difficult to identify and preserve all branches of the nerve The patient should be told the serious nature (likelihood of recurrence) of his parotid tumor, so that he will be prepared to accept temporary facial weakness if it should occur Too often he is assured the lesion is benign, that it can be shelled out under local anesthesia Yet, if minimal anesthesia is used, so that the nerve will not be anesthetized (while the patient is being asked to whistle periodically), the outcries of pain may prompt the operator to do a hasty and inadequate operation On the other hand, if the nerve is anesthetized with local anesthesia one can no longer know whether or not it is intact General (endotracheal) anesthesia is preferred Only minimal tumors that are found to be "benign" on frozen section should be excised without parotidectomy, and even in these a surrounding margin of normal parotid gland should be included

Parotid fistulas This complication is not common following excision of a tumor It develops much more frequently after traumatic injuries It is advisable to give the lesion time to close spontaneously for it usually does If after many weeks the fistula still has not closed a plastic repair or radical surgery may be required

HEMIMANDIBULECTOMY AND RADICAL NECK DISSECTION FOR TUMOR

This operation is representative of the group of radical head and neck procedures that must often be performed for cancer

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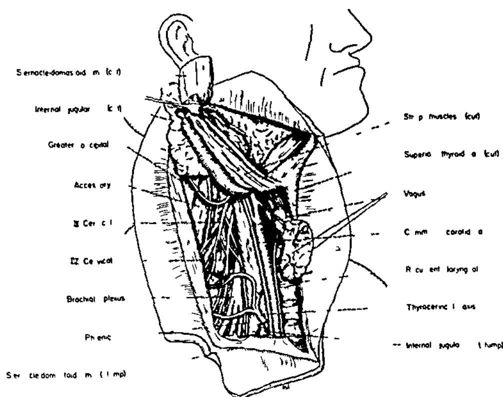


FIG 21—*Radical Neck Dissection* This operation requires familiarity with a number of anatomical landmarks First the skin flaps are developed in all four directions leaving the platysma attached Next the sternocleidomastoid and strap muscles are divided just above the clavicle and retracted upward exposing the brachial plexus scalenus anticus muscle phrenic nerve and the carotid sheath containing the carotid artery vagus nerve and internal jugular vein This vein is then divided and the mass swept upward after identification of the recurrent laryngeal nerve As the dissection nears the mandible the following nerves are identified and preserved hypoglossal lingual and the mandibular branch of the facial The spinal accessory nerve to the trapezius muscle runs beneath the sternocleidomastoid above and one may or may not elect to preserve it depending upon the extent of the malignant process The internal jugular vein is again securely ligated and divided near the jugular foramen as the muscle mass with attached areolar tissue and lymph nodes is excised from the mandible mastoid process and other points of origin or insertion The facial artery and vein are ligated and divided and the lower portion of the parotid gland is conveniently amputated

torily, his nerve paralysis resulted from the excision of a lipoma in the posterior cervical triangle In the instance of persons who are not required to perform manual labor, though trapezius paralysis may occasion little inconvenience

Ligation of the *internal jugular vein* usually results *in some* increase in cerebrospinal fluid pressure However, this is no particular problem unless bilateral neck dissection is planned, with ligation of

Preoperative Preparation

While the *biopsy* of the malignant tumor is being processed, the *chest x-ray* should be taken in a search for possible metastases, and a roentgen study of the mandible should identify the presence and extent of any bone involvement If the patient is debilitated because of long-standing inability to masticate and to swallow effectively, preoperative *alimentation* (3500 calories and 200 Gm of protein daily) should be given with a polyethylene tube introduced through the nose into the stomach

Since it has been shown that the *blood volume* in such patients may be reduced by almost a liter, preoperative blood transfusion may be indicated on the basis of hematocrit and hemoglobin values For operation itself, at least 6 pints of properly crossmatched blood should be available

Operative Considerations in Radical Neck Dissection

While it is not the purpose to discuss technic *per se* in this volume, *except insofar as it affects directly the problems of preoperative and* postoperative care, there are certain considerations in the radical head and neck procedures that deserve mention here (FIG 21)

The *blood loss* during a radical neck dissection is not usually massive at any one time, but it is apt to be continuous over a period of perhaps 3 or 4 hours The volume of blood loss at an operation is a function of the *rate of loss* and the *duration of the loss* Blood transfusion should be begun early in the operation, before any decline in blood pressure due to blood loss has occurred

*The technical aspects of this procedure also influence postopera-*tive care *Hemostasis* should be meticulous to avoid excessive bleeding beneath the skin flaps Injury to the vagus nerve in the carotid sheath or to the recurrent nerve will result, of course, in *paralysis of the vocal cord* on that side The *phrenic nerve* should be preserved to permit normal respiration and coughing in the post operative period Division of a *hypoglossal nerve* may interfere with swallowing Injury to the *spinal accessory nerve* paralyzes the trapezius muscle and results in shoulder drop However, some surgeons divide this last nerve deliberately along with resection of the sternocleidomastoid muscle The degree of disability produced by paralysis of the trapezius muscle will depend on the occupation of the patient We knew of a chauffeur who could no longer drive satisfac-

tube may be required for an extended period of time until the fistula has closed

Complications Some of the complications of radical neck dissection, with or without hemimandibulectomy, have been touched upon Early *hemorrhage* may occur due to slipping of the ligatures on the internal jugular vein To avoid this, at least one suture ligature should be placed at the time this vessel is divided high in the neck at surgery Late (secondary) hemorrhage from arteries may occur Postoperatively the common carotid artery lies just beneath the skin flap and may be exposed if the skin sloughs *Infection* may further increase the risk of late hemorrhage *Necrosis of the undermined skin flaps* (especially likely if the platysma muscle has been sacrificed and the skin denuded radically) is not rare *Collections of fluid* beneath the skin flaps may further retard skin healing *Displacement of the Kirschner wire* used as a strut or bridge over the excised portion of the mandible to preserve facial contour is frequent In addition, *headache* may result from increased cerebrospinal fluid pressure due to ligation of the internal jugular veins

The treatment of various of these complications is suggested by their natures Hemorrhage must be controlled Necrotic skin must be replaced, eventually, with skin grafts Fluid collections are aspirated or drained The use of catheter suction beneath the skin flaps (see under radical mastectomy) may reduce the incidence of such collections If the wire in the mandible becomes displaced it is usually removed to prevent pressure necrosis of the adjacent buccal mucosa with resulting salivary fistula Headache due to increased cerebrospinal fluid pressure gradually subsides as the opposite internal jugular vein and the vertebral veins adjust to the increased load imposed on them

THYROIDECTOMY

Preoperative Measures

The preoperative preparation for thyroidectomy will depend on the diagnosis and the indications for surgery If the diagnosis is that of a moderate sized nontoxic nodular goiter, established on the basis of the history, physical examination and a normal basal metabolic rate, then little special preparation is required The routine chest film should be examined to detect any substernal extension (FIG 22) It is advisable to examine the vocal cords by means of indirect

both internal jugular veins If both veins are ligated at the same operation a marked increase in cerebrospinal fluid pressure will result, and during the postoperative period severe headaches may be associated with papilledema Thus, if bilateral neck dissection is planned the two sides should be done at different operations Even if several weeks are allowed to intervene between stages, many surgeons prefer not to ligate the internal jugular vein on the second or less extensively involved side In recent years vascular homografts have been employed to permit resection of both internal jugular veins at the same operation, but this has a limited value

Tracheostomy may or may not be performed at the close of the operation It need not be done routinely, in our opinion, for respiratory obstruction is not often a fatal complication following radical neck dissection Moreover, tracheostomy is not a completely innocuous procedure It should be established when it is indicated but it should be avoided where it is not needed *If tongue or mandible is resected, however, tracheostomy should be performed*

The excuse often given for routine tracheostomy is that it facilitates postoperative nursing care, particularly that of tracheal aspiration by catheter suction—and so it does Our reply to this would be that the intern can perform the same function with naso tracheal suction at regular intervals Tracheostomy deprives the patient of his ability to cough effectively, the tube may become plugged (FIG 18), secondary hemorrhage may occur around the tube and stricture may develop after the tube has been removed, not to mention the adverse psychologic effect on the patient when he finds he cannot talk Tracheoesophageal fistula may develop due to erosion

Postoperative Care

Two important points in the early postoperative period are those of maintaining an adequate blood volume (follow blood pressure and hematocrit) and assuring adequate respiration The pressure dressing must not be too tight, and tracheobronchial secretions must be removed either by coughing or nasotracheal catheter suction Feeding is not a problem, since as a rule the patient can take some nourishment by the end of 48 hours from the time of operation However, if a salivary fistula develops secondary to operations involving the floor of the mouth, then feeding through a nasogastric



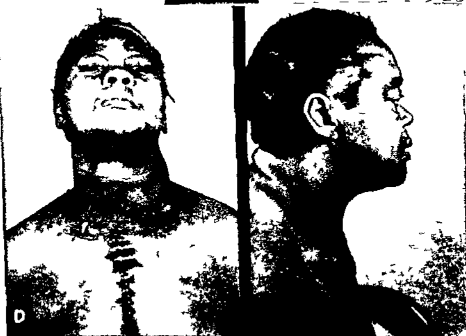


Fig 22—(*continued*)

(C) The total goiter removed The lower half of each lobe was situated in the mediastinum (D) Patient 3 days following surgery No complications





Fig 22—*Large Goiter Extending Substernally* (A) Roentgenogram in which the goiter may be seen to extend well below the thoracic inlet (B) Sternum has been split and the edges spread with a rib retractor Note excellent exposure of the superior mediastinum This maneuver is easily accomplished and causes little postoperative disability

(4) Iodine in the form of Lugol's solution or saturated potassium iodide solution—10 drops P O t i d
(5) Radioactive Iodine—from 5 to 15 millicuries P O

Radioactive iodine is of course most effective in reducing thyroid activity and is widely used for this purpose However, it is not used as a preoperative measure, though it is frequently used in the management of postoperative recurrence of hyperthyroidism

The daily dosage of propylthiouracil that is required to achieve the euthyroid level in the patient with thyrotoxicosis varies considerably from one person to another For example, a dosage of 300 mg given daily in divided doses may be effective in some individuals, whereas 800 mg may be necessary in others It is the rare patient whose excessive thyroid activity cannot eventually be brought to normal with the drug Nevertheless, there are patients in whom none of the antithyroid drugs is adequately effective When this situation is encountered, radioiodine should be employed as the definitive therapy in preference to surgery

There is still a definite place for the use of simple potassium iodide as the sole "antithyroid drug" to be used in the preoperative preparation This compound is rapidly effective in susceptible patients, and within 10 days operation may be performed with safety

The Operation

If the patient tolerates anesthesia induction satisfactorily the remainder of the operation usually proceeds uneventfully from the "thyrotoxic" standpoint (It is well to remember that local anesthesia is especially applicable to thyroidectomy) An endotracheal tube is now very commonly used, and good pulmonary ventilation thus achieved In the instance of the large, formerly toxic gland a blood transfusion may be needed, but often it is not Exposure of the recurrent laryngeal nerve promptly, on the side in question, enhances the operator's confidence in proceeding thereafter with dispatch At least one parathyroid gland should be identified and left *in situ*, and all excised tissue should be inspected for parathyroid glands before the tissue is placed in the specimen basin If a gland is found it should be implanted in neighboring muscle, for it may establish vasculature and survive Hemostasis should be meticulous at all times, to avoid respiratory obstruction due to postoperative hemorrhage We examine the cords with a laryngoscope at the close

laryngoscopy preoperatively. If one cord is paralyzed, such as does occur in the occasional patient, particular care is exercised to avoid any possibility of injuring the other recurrent nerve during surgery.

In contrast to the patient with a nontoxic goiter, the patient with severe thyrotoxicosis may require long and meticulous therapy. First, the diagnosis of hyperthyroidism must be established by means of

(1) History and physical examination
(2) Basal metabolic rate (B.M.R. normal—15 to +15)
(3) Protein bound iodine level of serum (normal 4 to 8 micrograms or gamma per cent)
(4) I^{131} uptake by *the thyroid gland (normal less than 40 per cent of administered* dose in 24 hours)
(5) Rate of conversion of radioactive inorganic iodine into radioactive protein bound iodine (conversion ratio)
(6) Therapeutic trial of inorganic iodine

Not all of these measures need be used in any given case, but special circumstances do arise in which particular tests may be required to clinch the diagnosis of hyperthyroidism. Low grade thyrotoxicosis due to a functioning adenoma in the elderly female may be particularly difficult to detect, in sharp contrast to fully developed hyperthyroidism in association with the other components (exophthalmos and diffuse goiter) of Graves' disease. The hypermetabolism associated with pheochromocytoma is at times erroneously diagnosed as thyrotoxicosis. Unfortunately, thyroidectomy or any operation other than for removal of the functioning adrenal medullary tumor may prove fatal.

Preoperative preparation of the thyrotoxic patient consists primarily of rest and sedation, therapeutic nutrition and, most important of all therapy directed toward reducing the thyroid activity. The best evidence of whether or not preoperative preparation has achieved the desired end consists of a gain in weight, a slowing of the pulse rate, and a decline in the B.M.R. associated with a general improvement in the patient's sense of well being. The serum PBI also declines. The agents that may be used to reduce thyroid overactivity are

(1) Propylthiouracil—from 100 to 200 mg. t.i.d. P.O. (This drug blocks the crucial oxidation of iodide to iodine preventing use in organic synthesis.)
(2) Tapazole—about 10 mg. *P.O.* t.i.d.
(3) Itrumil

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of the procedure, if they both move then but during the next few days the patient becomes hoarse and a cord is found not to move, one can confidently assume that the paralysis is due to edema and that function will return.

Postoperative Management

In addition to the usual close observation of the individual who has had an anesthetic, the patient who has had a thyroidectomy may present certain special problems. These include the development of respiratory obstruction, hypoparathyroidism, thyroid storm and hypothyroidism.

Respiratory obstruction. Postoperative Hemorrhage. The thyroidectomy wound should be drained in most patients. Asphyxia due to tracheal compression from hemorrhage is the most frequent fatal or near fatal postoperative complication following thyroid surgery. Moreover, one ominous aspect of this bleeding is its insidious nature. Since the thyroid is surrounded by strong fascia which is approximated with sutures in closing the wound, the bleeding may be confined beneath the fascia and may not be apparent until tracheal compression is far advanced. It is important to inspect the neck frequently in the early postoperative period and throughout the next 48 hours. If there is excessive drainage of blood or serosanguineous material, close observation should be even more stringent. If no unusual amount of bleeding is noted but the neck appears full (especially if the patient complains of tightness and of some difficulty in breathing) one should consider the possibility of reopening the neck. If reopening the wound becomes necessary, *tracheostomy* should be performed. This is one instance in which a timely tracheostomy can be absolutely life-saving. Most often the fatal error is to delay too long.

If tracheostomy is to be performed in the individual who is struggling to maintain minimal pulmonary ventilation, general anesthesia should be avoided, above all, intravenous pentothal may result in a fatality. Local anesthesia is adequate and is the agent of choice. For, should there be delay or difficulty in endotracheal intubation in connection with the general anesthesia that will abolish the strenuous voluntary respiratory efforts of the person threatened with asphyxia, further hypoxia and cardiac arrest may quickly follow. Even if the heart action is promptly restored, the subject may

have sustained irreversible brain damage There is at this writing a patient in a neighboring hospital, in his late twenties, who was found to have a full neck and some mild difficulty in breathing many hours following subtotal thyroidectomy Observation was continued for several more hours, during which time his condition worsened At this point, the most junior resident was instructed to take the patient to the operating room and to explore the wound and perform a tracheostomy There, instead of using local anesthesia, he allowed the anesthetist to use a general anesthetic, beginning with nitrous oxide To make matters worse, however (and the patient's respiratory symptoms had now become severe) intravenous pentothal was given when intubation was unsuccessful with nitrous oxide alone Thereafter spontaneous respiratory effort ceased but intubation could not be effected because of tracheal distortion by the hematoma Cardiac arrest followed Tracheostomy and thoracotomy with cardiac compression restored heart action, but brain damage was irreversible Two years have now passed, but the patient remains in the hospital comatose The expense can be computed, but the sustained anguish to his wife and family cannot be computed This entire tragedy, one which is by no means rare, could have been avoided by timely and intelligent management of the postoperative bleeding that will occur in the occasional patient despite the most meticulous operative hemostasis that should be effected at all times before the wound is closed

Laryngeal Pathology Other causes of postoperative respiratory obstruction are *laryngeal edema* and bilateral *vocal cord paralysis* Both of these complications are relatively rare Again, it is a good policy to examine the cords both before and immediately after surgery This excludes, on the one hand, preoperative paralysis of one cord that would necessitate extreme caution with the dissection on the opposite side at operation lest bilateral cord paralysis require permanent tracheostomy On the other hand early postoperative observation that both cords move ensures that the recurrent laryngeal nerve has not been injured on either side, a comforting bit of information to have when the patient develops a husky voice for a few days following surgery

The incidence of recurrent nerve injury appears to vary widely in different hands It has been estimated that the overall incidence of this complication is perhaps 3 per cent, ranging from less than 1 per

cent in experienced hands to even 10 per cent with inexperienced operators Bilateral cord paralysis usually will necessitate a permanent tracheostomy to avoid respiratory obstruction However, if only one recurrent nerve is injured respiratory obstruction is not usually a problem The patient's voice is husky or coarse, but this may rapidly improve to a considerable degree even if the cord paralysis persists, which it often does not

Hypoparathyroidism Second only to recurrent nerve injury, "surgical" hypoparathyroidism is the cause of considerable morbidity in patients who have had a radical subtotal or total thyroidectomy Unfortunately, a surprisingly large number of surgeons have little facility or confidence in identifying parathyroid glands at surgery Thus, it is perhaps not surprising that one or more of these small brown bodies are often delivered to the pathologist with the excised thyroid gland Again, as with recurrent nerve injury, the incidence of surgical hypoparathyroidism increases with the extent of the thyroidectomy The incidence of this complication varies, but permanent hypoparathyroidism occurs in perhaps 1 per cent of all cases, considering the country as a whole As with recurrent nerve dysfunction, temporary hypoparathyroidism, perhaps due to edematous changes surrounding the remaining glands, occurs in a considerably larger percentage (3 to 5 per cent) of patients Actually, the true incidence is rarely known because series of operations that reflect a high rate of complications, fatal and nonfatal, are not often reported The incidence of complications reported from the large, highly specialized private clinics by no means reflects the general level of surgical practice in the United States

The *signs and symptoms* of hypoparathyroidism consist chiefly of numbness and tingling in the extremities, associated with carpopedal spasm A tap with the finger over the facial nerve elicits a positive Chvostek's sign, and an inflated blood pressure cuff may elicit the previously latent carpal spasm, Trousseau's sign If no therapy is forthcoming severe respiratory symptoms may develop due to hypocalcemic tetany As soon as the condition is suspected and before therapy is begun, a blood sample should be drawn for the determination of serum calcium and phosphorus levels The normal serum calcium level is 5 mEq /L (9 to 11 mg /100 cc) The level will usually be reduced to below 8 mg /100 cc if hypoparathyroidism exists The serum phosphorus level (normally less than 4 mg per

cent) rises in hypoparathyroidism Once the blood specimen has been drawn one should not wait for the laboratory report, but should give calcium gluconate (1 Gm of 10 per cent solution) intravenously Immediate improvement in the patient's symptoms indicates that hypoparathyroidism does exist, and oral calcium gluconate or calcium lactate therapy (12 Gm /24 hours in divided doses) is begun This usually is sufficient to control the symptoms which are often temporary However, in some subjects parathormone must be employed intramuscularly in repeated doses until the long-acting vitamin D therapy given in massive doses takes effect Dihydrotachysterol (A T 10) is not often required when adequate vitamin D therapy is employed

Permanent hypoparathyroidism is a serious problem, both from the standpoint of expense to the patient and from the risk of respiratory disturbances and cataract formation associated with fluctuations in the serum calcium level

Thyroid Crisis (Thyroid Storm) Postoperative thyroid crisis has now become a rarity This is because effective antithyroid drugs such as propylthiouracil are available to render the patient truly euthyroid before operation, and because radioiodine therapy can be used for those rare thyrotoxic individuals who cannot be satisfactorily prepared for thyroidectomy Of course, a great many patients and/or their physicians choose radioiodine in preference to surgery, and this form of definitive treatment is effective

The *management of thyroid storm* has an exceedingly important prophylactic element No patient should be subjected to surgery who is still thyrotoxic If with prolonged and vigorous antithyroid therapy the patient cannot be rendered euthyroid, radioiodine therapy should be employed

Whereas admittedly the single most important factor in the management of thyroid storm consists of avoiding surgery in the still thyrotoxic subject, how can one treat the condition once it has developed? And what are the cause and nature of thyroid storm?

The etiology of thyroid crisis is still somewhat obscure It has often been suggested that thyroid crisis represents, in effect, adrenocortical failure or insufficiency, that is, that both thyroid crisis in hyperthyroidism and adrenal crisis in adrenal insufficiency reflect a lack of adequate adrenocortical function to meet current metabolic demands To support this thesis, it has been pointed out that pa-

tients with severe hyperthyroidism can be much improved by treatment with ACTH or cortisone, and that the condition of patients in *thyroid crisis may be substantially improved by intravenous corticosteroid therapy* Moreover, there is considerable evidence that there is a functional interrelationship between the thyroid and the adrenal cortex Nevertheless, it is unlikely that thyroid crisis is merely and simply the reflection of adrenocortical insufficiency The condition is probably far more complex than this Furthermore, not all patients with thyroid storm respond to intravenous hydrocortisone therapy In fact, it is our experience that the patient with *full-blown* thyroid crisis is likely to die of it regardless of what treatment is used Even so, there are measures that are to a degree effective These include sedation, oxygen therapy, cooling of the febrile patient, intravenous sodium iodide, intravenous hydrocortisone and digitalization where indicated

Postoperative Hypothyroidism A radical thyroidectomy, for either toxic or nontoxic goiter, may result in hypothyroidism For this reason a repeat B M R at 3, 6 and 12 month intervals post operatively is advisable Thyroid substance is given if indicated

FUNCTIONING PARATHYROID TUMOR

Hyperparathyroidism is due to hypersecretion by an adenoma in the vast majority of instances, very rarely is it due to hyperplasia of several or all of the parathyroid glands These adenomas are almost always benign, but occasionally they are malignant

Diagnosis of Hyperparathyroidism

That hyperfunction of parathyroid tissue exists is often manifested by renal stones or by osteoporosis, often painful, associated with pathologic fractures in some instances Bone cysts may form, and in severe cases there may be shortening of the spine with loss of stature These changes are produced by the mobilization of calcium (and phosphorus), and the diagnostic studies are concerned with demonstrating the increase in calcium mobilization and excretion

In brief, a serum calcium level that is above 12 mg per 100 cc, if confirmed, must be considered to reflect hyperparathyroidism (normal serum calcium level, 9 to 11 mg /100 cc) The serum phosphorus level is normally about 4 mg /100 cc but this value declines as the serum calcium level rises in hyperparathyroidism In addition to an elevated serum calcium level, which may not be present on a single

measurement, the urinary excretion of calcium is also elevated In practical terms, the patient should excrete less than 200 mg of calcium after three days on a diet free of milk or milk products (*low calcium diet*) If the urinary calcium excretion exceeds 300 mg /24 hours, hyperparathyroidism must be suspected unless the elevated calcium excretion can be otherwise satisfactorily explained The alkaline phosphatase level of serum is elevated only if there is fairly extensive bone involvement

Search for Parathyroid Adenoma

The operative exposure for excision of a parathyroid tumor is achieved through the usual collar incision, being extended downward by splitting the sternum when this is indicated It is unwise to excise normal parathyroid glands as they are successively exposed in a systematic search on either side for an adenoma in the neck While well over 90% of adenomas are found in the neck, they may also be found in the anterior or the posterior mediastinum It is important throughout the procedure to maintain careful hemostasis The parathyroid adenoma has the same brownish color as the normal glands In our experience the tumor is easily recognized once it is actually exposed Furthermore, the tumor has most often been found near a lower pole of the thyroid gland, deriving its blood supply from the inferior thyroid artery Biopsy of a suspected tumor, with frozen section identification, may be helpful Of three tumors found in the past year in 3 patients, one was at the left lower pole, one at the right lower pole and one in the carotid sheath adjacent to the right upper pole

Postoperative Care

As with thyroidectomy, it may be desirable to drain the neck wound Following removal of the adenoma there may be a rapid deposition of calcium in the calcium-deficient bones, and calcium therapy may be required to treat hypocalcemic tetany It is considered by some that the postoperative hypocalcemia that may develop is due more to the avidity of the bones for calcium than to a temporary hypoparathyroidism caused by atrophy of normal glands in the presence of a functioning adenoma However, these problems are not often serious ones

Prognosis If far advanced renal damage due to infection associated with calculi has not already occurred when the parathyroid

adenoma is diagnosed and removed, the prognosis is excellent Unfortunately, extensive renal impairment will be found to exist in many patients whose hyperparathyroidism is long standing In these individuals irreversible renal insufficiency may prove fatal

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10 *Operations on the Thoracic Wall*

RADICAL MASTECTOMY

Preoperative Considerations

IN THE PRESENCE of a possible breast cancer for which radical mastectomy is contemplated, a *chest film* should be requested to search for lung and spine metastases, assuming, of course, that the tumor is not considered inoperable on the basis of the physical examination alone Moreover, since the cancer occurs more often in older women, an *electrocardiogram* and a determination of the BUN are useful in excluding occult coronary and renal disease, respectively For surgery, from 1,000 to 1 500 cc of *blood* should be available, and the pathologist should be notified as to the approximate hour at which a *frozen section* examination will be required

It is advisable to talk frankly with the patient if she expresses a desire to learn in advance whether or not the breast will probably be removed Many patients now know that removal of the breast indicates that the tumor was malignant Therefore, to remove a breast for a benign lesion is rarely excusable, for thereafter the patient can hardly be convinced of the benign nature of the lesion When frozen section examination is available, the surgeon's optimistic view of his ability to diagnose carcinoma from the gross appearance of the lesion should not prompt him to begin radical mastectomy until a diagnosis of cancer has been returned, except in unusual instances

The *mortality* associated with "radical" mastectomy is very low Actually, physiologically there is little radical about the operation, save perhaps in connection with excessive blood loss when the surgeon does not believe in clamping or cauterizing open blood vessels as the operation proceeds In fact, the only death the writer recalls was in such a circumstance Large amounts of blood were carelessly allowed to escape until the patient was in deep shock Only then was a slow drip of blood begun and cardiac arrest presently occurred with a fatal termination Nevertheless, in the presence of adequate

anesthesia and supportive therapy the overwhelming majority of patients having radical mastectomy do well, probably because no serous cavity is opened to interfere with cardiopulmonary or gastrointestinal function

The Operation

The procedure should include wide excision of the tissues potentially involved by the tumor, including meticulous *en bloc* dissection of the axilla After outlining the skin flaps above and below the breast, we prefer to carry the excision from the axilla toward the breast, to avoid massage of tumor cell emboli into the veins before they have been divided (FIG 23) The pectoralis major muscle is divided at its fascial or tendinous insertion on the humerus and the pectoralis minor is freed from the coracoid process The pectoralis musculature is then removed superiorly along the clavicle and, more laterally along the cephalic vein which serves as a landmark between the deltoid and pectoralis major muscles Inferiorly and laterally the dissection is usually not extended beyond the margins of the serratus anticus and the latissimus dorsi muscles One should also avoid extensive dissection along the brachial vessels and over the shoulder, for this adds little to the cure rate while definitely increasing the *postoperative morbidity* The *long thoracic nerve* (*of* Bell) is spared as is the nerve supply to the latissimus dorsi muscle if this is feasible The pertinent branches of the axillary vein are ligated and divided When axillary dissection is complete and the entire mass (containing axillary contents of lymph nodes and fat musculature and breast) is swept anteriorly and free of the chest wall, the perforating vessels can be successively clamped and divided flush with the wall of the thoracic cage Skin grafting may be required

Postoperative Care

In addition to the usual supportive measures, plus a moderately firm pressure dressing and prophylaxis against pulmonary complications, several special problems must be considered First, if the skin wound has been closed under considerable tension (or the flaps cut too thin), some part of the margins may *slough,* requiring subsequent excision of the necrotic tissue with eventual skin grafting Such a contingency greatly lengthens the morbidity, often by a week or so Second, substantial *collections of serum* may form beneath the

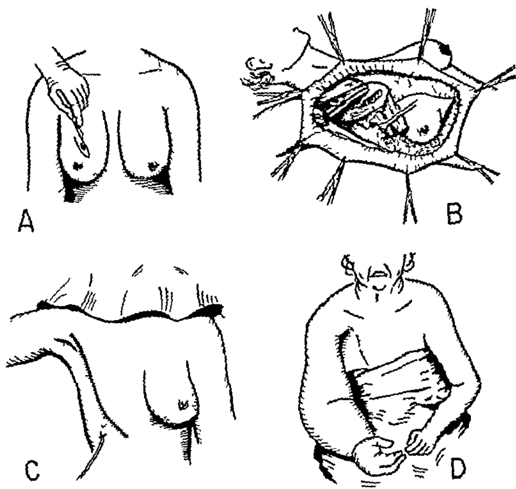


FIG 23—*Radical Mastectomy* (A) The potentially malignant breast mass should be removed by excision biopsy where possible Either a simple or an elliptical skin incision is employed so situated as to facilitate a second incision for radical mastectomy if the frozen section examination so indicates (B) We prefer to develop the upper and lower skin flaps and then to proceed to division of the pectoralis muscles at their insertions followed by the axillary dissection After this the entire mass is swept medially and excised from the chest wall *en bloc*—axillary contents musculature and attached breast By dividing the main blood supply early one hopes to minimize further blood borne metastasis (C) Catheter suction drainage beneath the skin flap collects a surprising volume of seroanguinous fluid in the trap bottle This results in a relatively dry wound dressing and more prompt sticking of the skin flaps (D) Lymphedema following radical mastectomy is common is due largely to excision of lymphatics but is aggravated by infection The degree is variable Repeated attacks of low grade cellulitis occur in some patients The skin may be sensitive to sunlight Wrapping with elastic bandage and elevation during sleep may help Hyaluronidase injections may facilitate fluid absorption One should foster a hopeful attitude because first the lymphedema tends to recede somewhat and second with time the patient becomes more reconciled to the disfigurement

large skin flaps unless a firm pressure dressing is applied and free and adequate drainage is afforded. Even better, the use of a rubber catheter introduced beneath the closed skin flaps, with continuous suction (FIG. 23), has proved most useful in preventing significant fluid collections and thus enabling the skin flaps to adhere to the chest wall quickly. Furthermore, the dressings remain dry and minimal redressing because of saturation with serum is required. A remarkable volume of drainage is collected in the suction trap bottle. Once the skin has adhered or "stuck" firmly to the thoracic cage a notable gain has been scored in rapid wound healing. *Pyocyaneous infections* respond fairly promptly to irrigation with mildly acid solutions. Since the wound is a superficial one with rather free drainage, purulent infection from staphylococcus is not a common complication. If drainage is inordinately prolonged, the possibility that *a small sponge has been left behind should be considered.*

Cellulitis and induration in the fat of the upper arm, especially in obese women, may be quite painful for a time. However, an optimistic prognosis can be offered regarding this particular problem, for it usually clears promptly. Furthermore, stiffness and pain on motion of the arm on the operated side should not prevent early use of the arm for hair-combing and other activity, for this will hasten rehabilitation.

Lymphedema of the entire arm following radical mastectomy may occur due to interruption of the lymphatic channels in the axilla, as a meticulous operation is designed to do. Nevertheless, this complication can be rather disfiguring and may be complained of bitterly by the patient. While no measures can be guaranteed to abolish the condition completely, a number of things can be done to improve the situation. They include (1) wrapping the arm with an elastic bandage from the fingers upward during the hours of sleep, (2) sleeping with the involved extremity elevated on a pillow, (3) injection of hyaluronidase into the extremity to enhance absorption of the fluid deposits into the venous system, (4) avoidance of exposure of the arm to direct sunlight in sensitive patients, for in some subjects sunlight produces a cellulitis in the edematous arm. Some surgeons have gone so far as to excise the thickened, edematous subcutaneous tissue, with skin grafting, yet, this has appeared too radical a procedure in a patient where "cure" of the cancer cannot be established for many more months. Finally, one can assure the pa-

tient that considerable spontaneous improvement may be anticipated in time as the lymph channels remaining plus new ones, become better able to carry the lymph from the arm

Other Breast Lesions

It is in order to mention certain diagnostic pitfalls which can be avoided in the management of breast pathology An important one occurs in association with beginning breast development in young girls It is not universally realized apparently, that one breast may begin to develop months in advance of the other When this occurs, the mother may bring the child to the physician for a "lump" beneath the nipple on one side If he is not aware of the probable true nature of the mass, which represents initial breast growth, the physician may excise the "tumor," thus preventing normal breast development in the future Instead, the mother should be apprised of the probable identity of the lump and she should be advised to bring the patient back monthly, or until the issue is settled, as it usually will be when the opposite breast begins to develop also Incidentally, transient unilateral or bilateral gynecomastia occurs in many boys during puberty but no surgery is indicated unless the condition persists

The diagnosis of breast masses in women with proved chronic cystic mastitis can be a most vexing problem, especially as one wishes to avoid further scars wherever possible Nevertheless as the woman grows older and the risk of carcinoma increases, multiple scars for definitive diagnosis may be unavoidable Likewise a certain amount of temporizing with small breast masses in teenage girls is virtually without risk since the overwhelming majority of such lesions are fibroadenomas which may vary in size and symptomatology with the menstrual period Again nipple erosin and breast masses in older women should be considered potentially malignant until this possibility has been excluded by biopsy

THORACOPLASTY

This operation which has many variants is usually performed to close dead space or to compress the lung At the present time it is perhaps most often employed to diminish the volume of one hemithorax after pulmonary resection For example following drainage of an empyema secondary to pneumonectomy it is almost impossible

to stop suppuration in the involved hemithorax without a thoracoplasty to obliterate the dead space. The use of thoracoplasty as a primary and "definitive" treatment for tuberculosis has happily been largely replaced by primary pulmonary resection, with or without secondary thoracoplasty.

The special *preoperative measures* required are, first, that enough compatible *blood* be available for the particular thoracoplasty procedure that is planned and, second, that *pulmonary function* be adequate to permit any additional limitation that the procedure might impose (*e.g.*, the use of thoracoplasty to collapse an upper lobe cavity). The lung function tests that are most practicable are presented on page 108. Needless to say, adequate *chest x-rays* should be on hand in the operating room to afford guidance as to the extent of thoracoplasty required and as to the side of the pathology, for thoracoplasties have been performed on the wrong side, with readily imaginable sequelae for both the patient and the surgeon.

At operation it is important to *avoid excessive blood loss,* when possible. Since once the dissection of the periosteum from a rib has been started the bleeding is difficult to control before the rib has been removed from its bed, an expeditious operator will lose much less blood than an unduly slow operator. *Perforation of the pleura* does not constitute a serious mishap, as long as the perforation is recognized and promptly closed to prevent pneumothorax and drainage of blood into the pleural cavity. In removing the first rib, care must be exercised to *avoid injury to the subclavian vessels*; this can be a serious problem. The *brachial plexus* is not likely to be traumatized unless one has the occasion to excise a cervical rib, which rarely improves the quality of the thoracoplasty. Finally, one should avoid performing too extensive a removal of ribs, for the postoperative *paradoxical motion may then be so excessive as seriously to impair* respiratory function of not only the lung on the operated side but of that on the opposite side as well. The wound may be drained for from 24 to 48 hours using a rubber catheter and continuous suction.

Postoperative care centers chiefly on the limitation of paradoxical motion (FIG. 24) of the chest wall overlying the beds of the excised ribs. A pressure dressing, with or without a small sandbag, usually controls this problem satisfactorily. To have an inexperienced intern on *night call remove the compression, even at the patient's* request, is to risk asphyxiation if the thoracoplasty has been extensive.

A second complication that occurs is *atelectasis* of the noncollapsed portion of the lung during the period of relatively ineffective respiratory expansion on the operated side This problem is avoided by encouraging effective coughing with or without nasotracheal catheter suction

A third complication is the collection of considerable volumes of *serosanguineous fluid* in the area in which the ribs were excised Not only may this fluid impair healing both mechanically and by becoming infected, but it may also represent a considerable loss of red

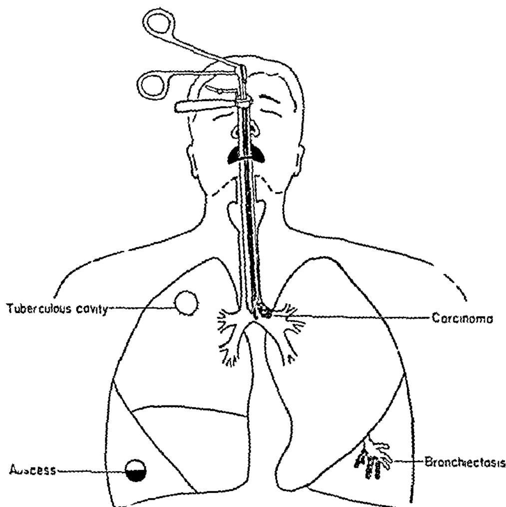


Fig 24—*Surgical Lesions of the Lung* The standard lung work up consists of the history physical examination plain PA and lateral chest x rays with planograms if indicated sputum studies with appropriate microscopic examinations and cultures bronchoscopy with biopsy and/or bronchial washings and bronchograms Skin tests are occasionally helpful Previous (old) x rays and current serial x rays during a few days of observation may afford valuable diagnostic clues

cells with depletion of the blood volume Most patients who have an extensive thoracoplasty lose from 1 to 2 liters of blood at operation and during the next few days The serial chest films requested for the purpose of determining the effectiveness of the collapse will also reveal any fluid collections Once such fluid has been aspirated it is possible more accurately to identify pulmonary atelectasis

After the immediate postoperative period when the blood pressure and pulse rate are used as guides to the need for transfusion, the hemoglobin and hematocrit levels should be followed to detect blood replacement requirements

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11 *Intrathoracic Procedures*

THE PREOPERATIVE and postoperative management of patients undergoing surgery for various diseases of organs within the thorax is often complex The special measures required are closely correlated with the physiologic functions of the organ in question and, of course, the functions of these organs are often vital For example, one must operate on a lung without producing asphyxia or on the heart without producing fatal ischemia of the brain and other viscera To accomplish these objectives safely the thoracic surgeon must have developed a thorough understanding of anatomy, physiology and pathology With this information he will be able to anticipate, prevent or treat the respiratory, circulatory, infectious and other problems which arise in the conduct of thoracic surgery As prototypes of procedures which often pose representative problems in thoracic preoperative and postoperative care, pulmonary resection, cardiac surgery and esophageal resection will be considered

PULMONARY RESECTION

Operations on the lung are now so commonplace that the resident in training is apt to be unaware of the painstaking studies in cardiopulmonary physiology that led to the present safe management of patients who require the resection of a segment, a lobe or a lung Nevertheless perhaps only in cardiac surgery are errors and omissions likely to manifest themselves so promptly in the form of morbidity or even mortality

Preoperative Measures

When the patient is admitted with a lung lesion (FIG 24) a definite series of studies should be performed in the vast majority of patients The objectives are (1) to establish the diagnosis, (2) to decide on what if any, surgery is indicated and (3) to prepare the patient properly for whatever operation is required

Establishing the Diagnosis The history and the physical examination are often most revealing Take the patient with hemoptysis,

for example If he does not smoke or has not smoked, *primary lung cancer* is unlikely The history of repeated pulmonary infections, often diagnosed as "pneumonia", suggests *bronchiectasis,* with or without *lung abscess* Associated cardiac symptomatology, plus the knowledge that the patient has had rheumatic fever as a child, is in favor of *mitral stenosis* as the cause of the hemoptysis Hemoptysis associated with venous disease suggests *pulmonary embolism* Again, hemoptysis in a patient with weight loss, night sweats and possible exposure to the bacilli renders the exclusion of *tuberculosis* mandatory Of course, there are many other causes of hemoptysis, including bronchial adenoma, chronic bronchitis, broncholiths, pulmonary arteriovenous fistula and "nonspecific" pulmonary hypertension

As with the history, much can often be learned from the physical examination, though even the most careful physical examination cannot replace the chest x-ray In point of fact, the chest film and the physical examination supplement each other In addition to the findings on *inspection* (*expansion symmetrical?*), *palpation* (tactile fremitus equal bilaterally?) percussion (dullness? hyperresonant?) and auscultation (character of ventilation, etc) of the chest, collateral evidence of much value may be discovered *Clubbing* of the fingers and toes suggests a chronic disease and, if there is no cyanosis the presence of pulmonary disease is perhaps more likely than heart disease Gynecomastia and arthritic changes may both reflect an intrathoracic neoplasm If there is cyanosis the clubbing may be due to pulmonary disease (such as a pulmonary A-V *fistula) but heart disease must be excluded If there is no* lung lesion on x-ray and atrial fibrillation is associated with a murmur characteristic of mitral stenosis especially in the afebrile patient, the hemoptysis is perhaps a reflection of pulmonary hypertension and congestion

Such are some of the types of diagnostic assistance to be derived from the general physical examination

Roentgen examinations assume a primary importance in the diagnosis of diseases involving the thorax and this is especially true of disease of the lung parenchyma "Routine" films should include both P-A and lateral views, omission of the latter will result in failure to detct some lesions that are situated behind the heart for example

From the plain film of the chest one can gain considerable information regarding possible diagnoses. The presence of a cavity with an air-fluid level indicates infection in most instances, whether due to tuberculosis, aspiration pneumonitis or fungi. However, such a lesion may also represent a lung cyst or cavitation (liquefaction necrosis) in a tumor. Cavitation may not be visible in a "solid" lesion until demonstrated by special *body section films* (planograms, tomograms). In contrast to diseases which are often detectable on a plain film, bronchiectasis may cause little more than minimal to moderate infiltration in the lower lobes, and the increased lung markings may be considered to be within normal limits unless *bronchograms* are performed. The use of dionosil, which is rapidly cleared from the lung has rendered the frequent repetition of bronchograms feasible. Bronchograms should constitute a step in the routine work-up of most patients with inflammatory lung disease or with suspected foreign bodies that are not visualized with the bronchoscope.

Bronchoscopy is also a most valuable procedure in the diagnosis of lung disease. This technic is usually employed prior to special roentgen studies, in fact, the tube for instillation of the radiopaque medium at bronchography is frequently inserted as the bronchoscope is withdrawn after bronchoscopy. Through the bronchoscope one inspects the major bronchi and the orifices of most of the segmental bronchi. Is there tumor, stricture or other deformity, inflammation, foreign body, bleeding or purulent secretion? And if so, from what bronchus is it arising or flowing? Next, even though sputum and gastric washings may already have been sent to the laboratory for study, additional secretions and/or bronchial washings are secured through the bronchoscope to permit aliquots to be sent for routine, tuberculosis and fungus cultures, and to the pathology department for tumor cell study, where indicated.

Skin tests and supraclavicular scalene node or fat pad biopsy may also prove valuable in the occasional patient. The usual skin test is, of course, the tuberculin test. In our experience, the finding of a "positive" or "negative" histoplasmin test has not materially assisted in the diagnosis or exclusion of histoplasmosis.

A negative supraclavicular biopsy excludes nothing, of course, but a positive biopsy may demonstrate tumor metastasis (rendering lung resection noncurative), tuberculosis, sarcoidosis or fungus

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disease For this reason, supraclavicular biopsy material should be divided into parts to permit routine and special cultures as well as the preparation of tissue sections for microscopic study

In summary, the preoperative measures commonly used for the diagnosis of lung lesions are

1 History and physical examination
2 Routine and special x-ray studies
3 Bronchoscopy, with collection of material for bacterial cultures and pathologic study, plus sputum already obtained by coughing or gastric washings
4 Skin tests
5 Supraclavicular biopsy
6 Angiography in some cases (*e g*, the "parenchymal" mass may prove to be a pulmonary A-V fistula or an aortic aneurysm)

Frequently all measures fail to disclose the nature of a lesion visible in the chest x-ray, and exploratory thoracotomy may be required for diagnosis and management When such a "silent" lesion is present, tumor granuloma (*e g* tuberculoma) or *hamartoma* is often found at operation

Certain Therapeutic Considerations

Special measures are indicated in special circumstances For example the patient with a lung abscess should have a period of intensive *antibiotic therapy* (*e g* penicillin, 10,000,000 units per day) and the patient with cavitary pulmonary tuberculosis may require months of streptomycin and para-aminosalicylic acid (PAS) or INAH therapy before the extent of resection required for residual disease is apparent Moreover, *nutritional therapy*, restoration of an adequate *blood volume* and *postural drainage*, where indicated, are highly significant aspects of therapy prior to pulmonary resection Nevertheless let us assume that antibiotic, nutritional, transfusional and other particular measures have prepared the patient for surgery, how can we know whether or not the lung function is adequate to permit thoracotomy perhaps with excision of an entire lung for cancer?

Lung Function Tests

General Considerations While an exhaustive evaluation of pulmonary function in the given individual may and often does require much time and technical assistance, clinical evidence of pulmonary

TABLE 13—*Average Normal Values in Pulmonary Function**

Total Lung Capacity (liters)	5 97
Vital Capacity (Simple) (liters)	4 78
Maximum Breathing Capacity (MBC) (liters)	80–120
Residual Volume (liters)	1 19
Arterial Oxygen Saturation (%)	97 1
Arterial Oxygen Content (Vol %)	20 3
Arterial Oxygen Tension (mm Hg)	95
Arterial Carbon Dioxide Content (Vol %)	49
Arterial Carbon Dioxide Tension (mm Hg)	40
Arterial Blood pH	7 4

* From Comroe J H Jr Forster R I II DuBois A B Briscoe W A and Carlsen E The Lung—Clinical Physiology and Pulmonary Function Tests Chicago, Year Book Publishers Inc 1955

function is adequate for practical purposes in 85 per cent of the patients coming to surgery (TABLE 13)

The basic factors in lung function are pulmonary *circulation*, *ventilation* (volume and distribution again important) and alveolar *diffusion surface* (reduced by senile emphysema pulmonary fibrosis, pneumonectomy, etc) Thus the definitive evaluation of pulmonary functional reserve must aim at the evaluation of each of these three major components of lung function However, since if all are adequate the efficient oxygenation of the blood and the removal of carbon dioxide from the blood will be manifested the measurement of exercise tolerance affords considerable information regarding lung function

History and Physical Examination In Assessing Lung Function If the patient is dyspneic at rest or on slight exertion, pulmonary resection will usually be contraindicated, certainly careful pulmonary function evaluation should be carried out before surgery, and surgery should be abandoned if the clinical impression is supported by the function tests In fact where the clinical findings of dyspnea at rest are in conflict with laboratory findings of good pulmonary function, one is wise to repeat the laboratory tests For even if the intent is to excise at operation only the diseased and atelectatic apical and posterior segments of the upper lobe, sparing all functioning lung tissue the patient may be rendered a "pulmonary cripple' by surgery The reason for this is that thoracotomy frequently results in some reduction of lung function on the operated side even if no fibrinous exudate reduces the volume of the remaining lung and if no retained bronchial secretions result in

patchy or segmental atelectasis on the involved side Therefore, especially during the early postoperative period when pain and the healing wound may further embarrass the already only barely adequate respiratory function, pulmonary insufficiency may result

On the other hand the patient with good exercise tolerance is usually a satisfactory candidate for surgery regardless of what the function tests show, here again however, the clinical findings and the laboratory findings are usually in agreement and when they are not in agreement a cautious approach to surgery is justified

In addition to assessing the presence or absence of dyspnea at rest and on exertion, past or present, one should also look for cyanosis, clubbing of the fingers, widening of the P-A chest diameter and fixation of the thorax in an attitude of permanent inspiration The last, of course suggests pulmonary emphysema Patients who have had chronic bronchial asthma silicosis, chronic pulmonary tuberculosis, pulmonary cystic disease or bronchiectasis often have far more parenchymal pathology than is visible on the chest film

Physical examination should also include auscultation of the chest, including evaluation of pulmonary ventilation and the heart sounds In the course of the clinical examination the vital capacity can be determined with fair accuracy with the use of one of the bedside devices that are commercially available (FIG 25), and the "normal" vital capacity for the height of the person in question can usually be found in a table printed on the instrument Of course, the vital capacity reflects only one of three primary components of lung function namely ventilation, and it by no means constitutes a complete evaluation of ventilation However, a normal "timed' vital capacity the ability to exhale a normal volume of air in a specified period of time is reassuring information

A *normal vital capacity frequently is associated with normal pulmonary* blood flow and diffusion surface, and a reduced vital capacity often reflects reduced diffusion surface Nevertheless, these factors do not always parallel each other in degrees of impairment For example the vital capacity and total lung volume for air could be normal in the presence of advanced cystic disease with or without emphysema *per se* even though the membrane surface for gas diffusion and the pulmonary capillary bed available for blood flow were *drastically reduced Again the importance of timing the* length of expiration in determining the vital capacity is that the bronchostenosis of the emphysematous patient tends to trap air,



Fig 25—*Evaluation of Lung Function Above* With the *spirometer* one can obtain simple vital capacity timed vital capacity and maximum breathing capacity Even so this evaluates only certain aspects of pulmonary ventilation The other two members of the pulmonary function triad alveolar membrane diffusion surface and pulmonary circulation must be investigated by other technics *Below* A simple dust pan apparatus for measuring vital capacity The mouthpiece is disposable and the normal range of values is printed on the instrument (McKesson-Scott Vital Capacity Apparatus McKesson Appliance Company Toledo Ohio)

patchy or segmental atelectasis on the involved side Therefore, especially during the early postoperative period when pain and the healing wound may further embarrass the already only barely adequate respiratory function, pulmonary insufficiency may result

On the other hand the patient with good exercise tolerance is usually a satisfactory candidate for surgery regardless of what the function tests show, here again, however, the clinical findings and the laboratory findings are usually in agreement, and when they are not in agreement a cautious approach to surgery is justified

In addition to assessing the presence or absence of dyspnea at rest and on exertion, past or present one should also look for cyanosis clubbing of the fingers, widening of the P-A chest diameter and fixation of the thorax in an attitude of permanent inspiration The last, of course, suggests pulmonary emphysema Patients who have had chronic bronchial asthma, silicosis, chronic pulmonary tuberculosis, pulmonary cystic disease or bronchiectasis often have far more parenchymal pathology than is visible on the chest film

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mary components of lung function pulmonary ventilation, pulmonary diffusion (alveolar) surface and pulmonary blood flow Differential *bronchospirometry* is used to evaluate function in the lung to be excised as well as in that which is to remain, that is, to evaluate the loss in the total function that pneumonectomy would produce This technic, while highly attractive in theory, is not easily applied in practice For one thing the very patients in whom such data would be most desirable for estimating the operative risk are often unable to tolerate the stenotic breathing which the introduction of the endotracheal tube entails However, when reliable data delineating the function of each lung can be obtained, they may be quite helpful

To summarize, lung function tests are useful to determine operability, to assess surgical results (as following pulmonary decortication), to follow the progress of pulmonary disease (*e g* sarcoidosis or histoplasmosis), to evaluate medical therapy (*e g*, in emphysema), to aid in diagnosis (*e g* timed vital capacity and air trapping in emphysema), to evaluate the effects of various types of anesthesia, and to assess pulmonary disability for medicolegal purposes A clinical appraisal employing the history, the physical examination that includes measurement of exercise tolerance, the determination of the timed vital capacity, and the chest x-ray and fluoroscopic examination afford adequate information to permit practical preoperative assessment of pulmonary functional reserve in most patients

Special Preoperative Orders

In addition to routine preoperative orders, it is advisable to have the patient with suppurative disease perform *postural drainage* immediately prior to the induction of anesthesia This facilitates anesthetization and ventilation during surgery, and it reduces the flow of contaminated secretions into previously healthy lung In tuberculosis such a flow often results in a spread of the disease in lung abscess with a large cavity such spillage can result in pneumonitis or even in drowning

Pulmonary resection should not be started without there being typed and crossmatched 3 000 cc of compatible blood For, while only 1 000 cc may be required in many patients the difficulty of the operation and accompanying blood loss vary markedly from

hence, this patient will not be able to exhale as rapidly because of the resistance to the outflow of the air by virtue of the reduced diameter of the bronchi on expiration as compared with inspiration Yet, if sufficient time is allowed for complete expiration of the air trapped behind stenotic smaller bronchi, the emphysematous patient may exhibit a normal vital capacity with respect to volume alone (time relationships being disregarded) Emphysema may produce pulmonary hypertension with cor pulmonale, the result of a reduction in the volume of the pulmonary vascular bed with or without increased pulmonary arteriolar resistance due to arteriolar thickening

Roentgen Studies Much of value in estimating pulmonary function can be deduced from chest fluoroscopy and inspection of the P-A and lateral chest films For example, total lung volume, deformity of the thoracic cage and fixation of the diaphragm may all be noted, not to mention pleural effusion, pneumothorax and space occupying lesions

Laboratory Measurements Aside from simple vital capacity evaluation, for which elaborate equipment is not required, further lung function studies do require a certain amount of special equipment and technical assistance However, the common *spirometric measurements* are less demanding of specialized personnel than certain other tests These spirometric studies include more careful checking of the *timed vital capacity* evidence of air trapping gross estimation of residual lung volume and measurement of the *maximum breathing capacity* The last reflects the physical capacity of the individual to inhale and to exhale air rapidly, as would be required on severe exercise Since only a portion of the vital capacity is used in these rapid respirations, a patient who has a reduced vital capacity (as in pulmonary fibrosis) might exhibit a normal maximum breathing capacity Many factors are involved in achieving a normal maximum breathing capacity, not the least of which is a willingness on the part of the patient to exert his best efforts Hence more than one measurement is indicated if the first is abnormally low

The measurement of the *residual lung volume* is important in certain patients Determinations of the peripheral *arterial oxygen saturation, pH* and *P_{CO_2}* at rest and during exercise afford a rather practical appraisal of the co-ordinated efficiency of the three pri

development of a bronchopleural fistula, if saline irrigation of the hemithorax removes fine clots and any detritus before the chest is closed and if prompt lung expansion obliterates dead space. Atelectasis is minimized by most of the measures already listed, in addition to vigorous coughing, deep breathing and nasotracheal catheter suction during the first 72 hours postoperatively.

Postoperative Measures

Antibiotics may or may not be instilled into the hemithorax at the time of closure and then continued parenterally. We still use them. Two *drainage tubes* should be inserted into the hemithorax at the time of closure, one in front and above to remove air and one below near the diaphragm to permit the escape of serosanguineous effusion. When the entire lung has been removed no tubes are inserted, since it is desirable to allow the hemithorax to fill with sterile plasma that will subsequently become organized; this reduces overdistention of the remaining lung. In this connection, following (total) pneumonectomy one should adjust the pressure in the operated hemithorax as soon as the chest has been closed and the patient turned on his back. This may be done by inserting a no. 18 needle through the third interspace, attached to a 50 cc syringe whose barrel has been wet with sterile saline. Air is aspirated until the negative pressure will draw the barrel forward sharply when one has pulled it backward to the 20 cc mark. If the negative pressure is too great or if a positive pressure exists, serious cardiopulmonary dysfunction may result due to displacement of the mediastinal vessels and to embarrassment of the remaining lung. A 3-way stopcock facilitates aspiration of air.

The chest tubes are connected to one or two underwater seal drainage bottles and 10 cm. of water suction may be applied, if desired. During this period it is important that the column of water in the drainage tubes oscillate downward and upward with each respiration. This indicates free communication between the hemithorax and the drainage bottle; if the column does not oscillate, the fluid (blood) in the tubes may have clotted. If the tubes do become plugged one cannot know without an x-ray whether fluid and/or air is collecting within the chest or not. If this does happen serious pulmonary embarrassment from air, blood or pleural effusion may precipitate an emergency that at times may re-

one patient to another If an adequate amount of blood is not available to replace massive hemorrhage due to injury to a major vessel, one may lose the patient

The Operation

The care with which the pulmonary surgery is performed has much to do with the prevention of several important postoperative complications which can markedly increase the morbidity and mortality The most prominent of these complications are pneumothorax, hemorrhage hydrothorax, atelectasis, infection and bronchopleural fistula The creation of air leaks unnecessarily should be avoided, and existing leaks should be sutured where possible (TABLE 14) Proper placement of the thoracotomy drainage tubes will minimize the amount of fluid that collects in the hemithorax Pleural adhesions are best ligated to prevent postoperative bleeding, and it is obviously essential to make certain of secure ligation of pulmonary vessels Infection is rendered unlikely if spillage from a cavity is avoided, if careful bronchial stump closure prevents the

TABLE 14—*Space Problem Following Pulmonary Resection Management*

1 Air leaks and hemostasis are meticulously attended to during surgery
2 Avoid infection by minimizing pleural contamination (as in resecting abscess or tbc cavity) irrigation of hemithorax with sterile saline prior to closure and antibiotics when indicated
3 Place two thoracotomy drainage tubes carefully one in front and above for removal of air and one behind (actually laterally to avoid the patient s lying on it) and below to drain effusion and blood
4 Repeated postoperative auscultation and serial chest roentgenograms to detect immediately any atelectasis pneumothorax or hemohydrothorax These can produce a space between the lung tissue and the ribs of the ipsilateral hemithorax
5 Vigorous and diligent turning deep breathing coughing and nasotracheal catheter suction to remove secretions and enhance effective pulmonary ventilation Bronchoscopy occasionally required
6 If space problem does develop
   a Aspirate air or fluid with syringe and needle If air leak continues suspect *bronchopleural fistula* and insert tube into the space by means of P A and lateral chest films or at fluoroscopy Connect to underwater drainage and suction
   b Withdraw ineffective tubes if not already out
   c Antibiotics if not begun already
   d Continue measures listed under 4 and 5 above
   e Reoperation if space does not close after several weeks
      i Partial thoracoplasty only
      ii Additional pulmonary resection (of segment involved by bronchopleural fistula) and partial thoracoplasty

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quire a second thoracotomy It is well to mark with adhesive tape the level of the fluid in the drainage bottle at the time the chest tubes are connected to it, this allows one to estimate at a glance the volume of serosanguinous drainage during the hours following surgery If the drainage volume is large but serosanguineous, further transfusion only may be required If the loss is almost pure *blood, is excessive and does not diminish as the hours pass, the* chest may have to be reopened to ligate the bleeding point Bleeding diatheses do occur in pulmonary surgery, but if the blood clots and the platelet count is adequate an open and bleeding vessel must be suspected

Measures which promote good pulmonary ventilation are of paramount importance following lung resection and following pneumonectomy they can represent the margin between life and death Not only is adequate respiration sought for but one must also prevent atelectasis of the remaining portions of the lung on the operated side If these segments, lobe or lobes collapse during the immediate postoperative period when fibrin clots are available to cover and quickly to imprison them in the collapsed position, full re-expansion of these segments may not be achieved and lung function may be reduced even below the level which existed pre operatively Once the lung is expanded adhesions soon form between the pleural surfaces bronchial secretions interfere less with ventilation incisional pain and resultant inactivity soon decline, and the hazards of atelectasis with attendant infection and reduction in lung volume thereafter recede

Prevention of Postoperative Atelectasis—Further Comment Prophylaxis is begun before operation through the reduction of tracheobronchial secretions During operation the surgeon will be careful not to interfere with the venous drainage or bronchi to segments that are to be spared Air leaks will be minimized, and in this connection the use of a spray of gel foam has been reported to seal raw lung surfaces and greatly reduce air leakage Careful hemostasis will reduce postoperative bleeding the clots from which may compress the lung

Next, opiates should be used sparingly so as not to depress respiration The patient should be turned from side to side frequently, and the nasotracheal catheter suction should be employed until he is fully awake Thereafter he should be made to cough

every 2 hours—and even more often if on auscultation both lungs are not ventilating satisfactorily This act of coughing can be made far less painful if the nurse or the doctor reaches around the patient's chest and gently but firmly compresses the thoracotomy wound as the patient creates the expulsive force of the cough If effective coughing is achieved, nasotracheal catheter suction may be avoided However, if the patient cannot or will not cough, the catheter for suction will stimulate coughing as it enters the trachea After one encounter with tracheal catheter suction the patient usually prefers to cough

Another prophylactic measure of major value is that of securing a portable chest film on the evening of surgery and on the next two days This is a routine the value of which is great From time to time one may be tempted to consider these films an unnecessary expense to the patient or to the community, but he soon regrets the omission By these three routine films one can be alerted to early atelectasis, pneumothorax or collections of fluid (FIG 26) It is far easier to re-expand lung tissue which is only partially atelectatic than it is that which is wholly atelectatic Coughing and deep breathing perhaps fortified with nasotracheal catheter suction, usually suffice for the management of partial atelectasis, but repeated bronchoscopy may be required in the more severe grades of extensive atelectasis If the chest tubes are not functioning satisfactorily, it may be necessary to aspirate collections of fluid and air with a syringe and needle or, at times, to insert an additional tube

Postresectional Infections The best prophylactic measures, other than proper technic at surgery to prevent contamination of the pleural cavity or subsequent bronchopleural fistula, are those directed toward maintaining good expansion of the remaining lung tissue Antibiotics are usually employed postoperatively

When *empyema* does form it must be evacuated This objective may occasionally be achieved with simple needle aspiration (FIG 27) or with closed catheter drainage (FIG 28), but open thoracotomy and decortication will often be required Particularly serious is the empyema which may develop in the plasma collection which fills the hemithorax following pneumonectomy This confronts the patient and the surgeon with a volume of pus that may measure several liters The usual findings are that the patient begins to run fever on the seventh or eighth postoperative day, often after an afebrile

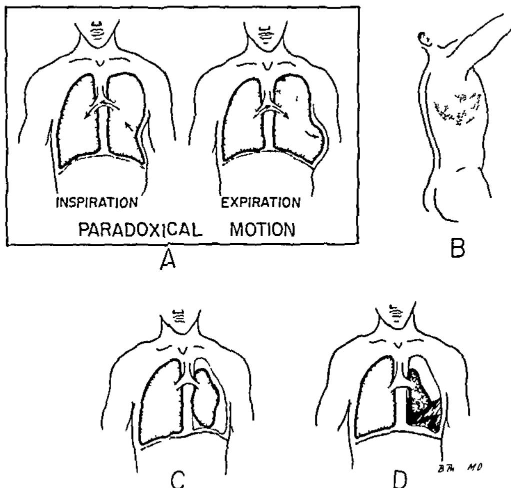


FIG 26—*Complications of Thoracotomy* (A) Paradoxical movement greatly impairs pulmonary ventilation (and cardiopulmonary hemodynamics) and asphyxiation may result The condition may follow the fracture or removal of an excessive number of adjacent ribs or it may be due to separation of the rib and muscle closure and may precede separation of the skin as well (B) Relatively massive collections of blood and/or fluid may occur between the muscle layers and the ribs particularly where thoracoplasty was performed Infection may develop Aspiration and/or surgical drainage may be required (C) Pneumothorax or left main stem bronchial occlusion by secretions with atelectasis of the left lung Prevent pneumothorax by postoperative tube drainage Effective coughing and intratracheal suction plus bronchoscopy on occasion will keep the major bronchi patent (D) Hemo hydro pneumothorax Empyema (pyothorax) may follow perhaps associated with bronchopleural fistula However, collections of fluid and/or air are usually avoided by adequate post thoracotomy tube drainage If the lung was not involved by the operation one tube below may suffice if pulmonary resection was done an additional tube is placed anteriorly above to aspirate air Routine post thoracotomy chest x rays the afternoon of operation and the following two days constitute wise precautionary studies

period following the mild febrile response to surgery The staff hopes that the fever is due to almost anything other than an empyema, but fluid is aspirated from the chest for culture Since the fluid is not frankly purulent and the odor is not yet foul, there is still a chance that it is not infected Unfortunately, by the time the cultures have disclosed bacterial growth the fever is now well established, and when further fluid is aspirated it has a foul odor and is more obviously purulent This discovery eventually requires

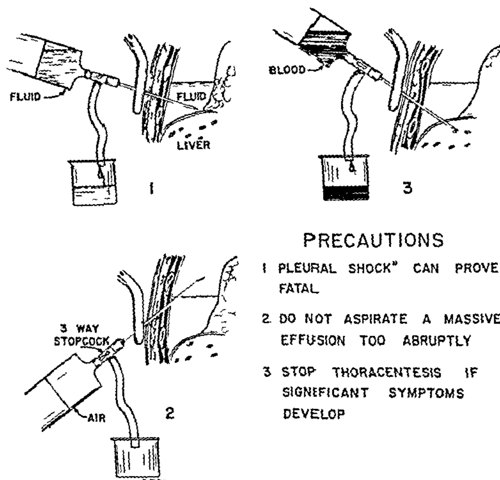


FIG 27—*Thoracentesis* The aspiration of fluid and/or air from the thorax can be a life saving measure If upon aspiration of air a negative pressure cannot be produced closed tube drainage (FIG 28) will usually be required Grossly bloody fluid may be due to the tear of an adhesion in tension pneumothorax due to a ruptured bleb to carcinoma involving the pleura tuberculosis trauma or to other more rare conditions If the fluid has an offensive odor it may be infected (empyema) (Modified from Lindskog G E and Liebow A A Thoracic Surgery and Related Pathology New York Appleton Century Crofts Inc 1953)

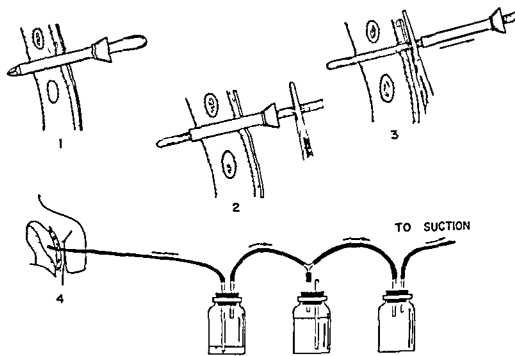


Fig 28—*Clo ed (Water Seal) Chest Drainage* The introduction of a tube into the che t is basically similar to paracente is A nick is made through the skin and the trochar is then gradually advanced through the subcutaneous tis ue mu cle interco tal bundle and parietal pleura In an extreme emergency when a trochar is not available the kin can be inci ed and the tip of the catheter rammed through the chest wall with a Kelly hemo tat Since either fluid or air will u ually have forced the lung away from the che t wall at the ite where the tube is to be introduced (determined with both PA and lateral views) the lung is not often injured On occa ion however tubes have been introduced far into the lung the liver and the peritoneal cavity—and even into the intrathoracic tomach that has traversed a diaphragmatic defect U e local an esthesia

To drain pus or blood the tube hould be inserted through the seventh eighth *or ninth interspace in the po terior axillary line (drainage from the bottom of the* barrel) Of course if the fluid is loculated the tube is in erted accordingly Avoid a po terior tube where pos ible for it cau es the supine patient discomfort To drain air as in tension pneumothorax the tube is inserted in the econd or third inter space anteriorly

It is essential that the long tube in the fir t bottle extend beneath the water (water eal) but suction is not always required The amount of suction applied is regulated by the length of the long cylinder that extends beneath the water in the middle bottle The third bottle is to protect the suction pump from spill over from the first and second bottles If no uction is de ired one drainage bottle with underwater seal uffices The che t tube may be clamped and then disconnected from the bottle in order to end the patient to x ray However if there is rapid air leakage from the lung the hazard of tension pneumothorax from even brief occlusion of the catheter is great

open drainage with rib resection, though it may be necessary to employ closed tube drainage until the inflammatory reaction to infection has reduced the risk of mediastinal shift Following adequate drainage, a thoracoplasty will be needed to close the dead space to prevent a reaccumulation of the pus Thus, instead of being discharged from the hospital ten days after an uncomplicated pneumonectomy, the depleted patient is discharged after six weeks, having had three operations instead of one Antibiotics are of little assistance after a large collection of pus has formed Again, drainage is mandatory

To summarize, postoperative management following pulmonary resection is directed toward

1 Providing adequate general pulmonary ventilation
2 Replacing any blood deficits while avoiding overtransfusion
3 Preventing atelectasis
4 Preventing infection
5 Early detection and management of complications that include hemorrhage, pleural effusion, pnuemothorax, atelectasis due to plugged bronchi, empyema and bronchopleural fistula

CARDIAC SURGERY

Perhaps no other type of surgery at the present time requires more meticulous preparation and planning than does surgery of the heart and great vessels The reason for this is that the penalty to the patient for errors in diagnosis, management or technic may be sudden death

Diagnosis

Since the range of possible structural and/or functional pathology is so great in the various heart diseases, it is not surprising that a variety of relatively specialized equipment is used Yet even so, the study always begins with the detailed *history* and *physical examination,* for it is the signs and symptoms suggestive of cardiopulmonary disease which prompt the patient the parents or the family physician to seek specialized help Such findings include dyspnea, edema, cyanosis chest pain clubbing of the fingers, abnormal fatigue, retarded growth and development, heart murmurs, cardiac arrhythmias, cardiac enlargement, rales in the lung fields, ascites, venous engorgement, precordial thrills abnormal pulsa-

tions, hypotension in the legs associated with hypertension in the arms and other less prominent phenomena Obviously, therefore "cardiopulmonary disease" may manifest itself in a variety of ways Furthermore the term "cardiopulmonary" is used advisedly, for the heart and the lungs constitute a single functional unit, each affecting the other

The *electrocardiogram* provides valuable evidence of disturbed cardiac physiology in many circumstances The precision of such information varies from the accurate correlation of coronary artery disease with specific ECG changes, to the less specific evidence of right heart strain in congenital heart disease that is associated with an increased right heart work load Even less specific data are those which reflect ionic imbalance, such as the ECG changes of hyperpotassemia and hypopotassemia since the ECG changes reflect total ionic influences rather than the potassium influence *per se* Notwithstanding characteristic "potassium effects" in the ECG do usually bear a practical relationship to the serum potassium level when it is significantly abnormal Finally, the various types of cardiac arrhythmia are readily diagnosed with the ECG

Roentgenography The trained observer can deduce much diagnostic information from plain P-A, lateral and oblique views of the heart and great vessels (1) Simple cardiac enlargement and pulmonary congestion would be noted, (2) aneurysms of the heart or aorta would be suspected (3) the pulmonary artery shadow would be more prominent on the film and on fluoroscopy in the presence of a patent ductus arteriosus (4) the aortic shadow would be less prominent just distal to the arch in coarctation, (5) the left atrium would be enlarged and often compress the esophagus (seen with barium swallow) in both mitral stenosis and mitral regurgitation, (6) the configuration in tetralogy of Fallot would be fairly characteristic and (7) in pure or isolated pulmonic stenosis the vascular markings in the lung fields would be less prominent than normal These and other data can be deduced from appropriate plain chest films

In addition *angiocardiography* can be very helpful With this technic which does involve certain risks one may demonstrate various types of dilatations or obstructions or he may disclose abnormal passages or communications between great vessels or between the several chambers of the heart Examples would include

the demonstration of superior vena caval thrombosis, pulmonic stenosis, the immediate passage of the radiopaque medium into the aorta from the right ventricle in the presence of tetralogy of Fallot with its "overriding" aorta, an aneurysm of a ventricle or of the aorta or the passage of the medium from the well filled aorta through a patent ductus into the pulmonary artery Such are, then, the types of information that may be obtained

Despite the value of angiocardiography, however, it is only one tool that can be used in diagnosis Even where the study is technically perfect with regard to vascular filling and timing of the exposure of the serial films, it cannot divulge certain types of information Specifically, the angiocardiogram is not particularly helpful in the presence of left to right intracardiac shunts, since the direction of flow results merely in a dilution of the medium entering the right heart While the dilution of the medium in the right heart may be detected, this is far less conclusive evidence of an abnormal shunt than is the demonstrated passage of the medium through a shunt Therefore, since blood flows from an area of higher pressure to an area of lower pressure, and since left heart pressures are normally higher than right heart pressures, the angiocardiogram is less helpful in the presence of left to right (acyanotic) than in right to left (cyanotic) shunts

Thus despite the value of the clinical examination, ECG, and angiocardiogram additional precision in diagnosis is required, and this is achieved by measurements of intracardiac pressures and oxygen saturations with right heart catheterization

Cardiac Catheterization It would be difficult to exaggerate the importance of cardiac catheterization (FIG 29) in permitting an accurate diagnosis of the lesion present in many types of congenital heart disease Whereas mitral stenosis and patent ductus arteriosus can usually be diagnosed without special studies, the cyanotic and noncyanotic intracardiac shunts can usually not be accurately interpreted and their importance assessed until the data from cardiac catheterization are available

The data derived from the passage of the cardiac catheter through an arm vein, into the superior vena cava and thence into the right atrium right ventricle and the pulmonary artery take several forms First the catheter itself may pass through a septal defect, thus the tip of the catheter may be seen at fluoroscopy to pass from the right

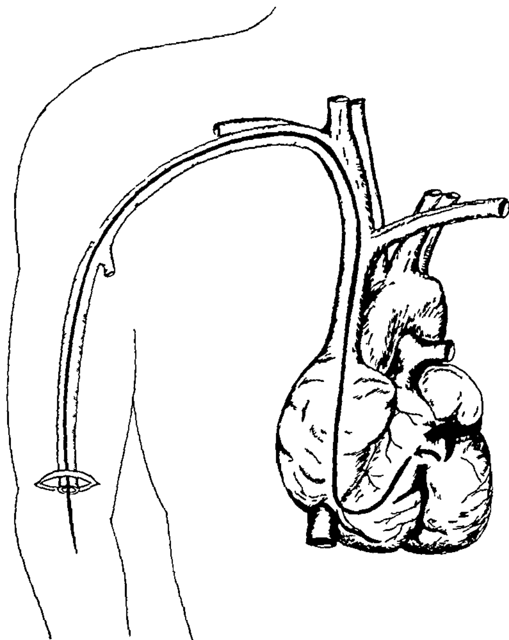


FIG 29—*Cardiac Catheterization* Diagnostic data consist of blood oxygen saturations and pressure relationship in addition to passage of the catheter through the defect itself upon occasion For example the presence of an interventricular septal defect (left to right shunt) would be reflected in an elevated oxygen saturation and an elevated mean pressure in the right ventricle and the catheter might be passed into the left ventricle and perhaps into the aorta The direction of any shunt depends of course upon the relative pressures between the two chambers involved Normally left heart pressures are greater than right heart pressures

atrium to the left atrium, from the right ventricle to the left ventricle, or from the pulmonary artery through the patent ductus into the aorta Second, suppose that the blood oxygen saturation increases abruptly as the catheter passes from the superior vena cava into the right atrium, this indicates a flow of fully saturated blood from the left atrium where the pressure is higher, through an interatrial septal defect, into the right atrium where the pressure is lower than that in the left atrium Increased oxygen saturation in the right ventricle (but not in the right atrium) suggests an interventricular septal defect Third pressure differences are of diagnostic significance For instance, if the pressure in the right ventricle is abnormally high (normal, about 20 mm Hg systolic) and that in the pulmonary artery is quite low, then stenosis in the pulmonary outflow tract is assumed to exist for normally the pressure in the right ventricle and that in the pulmonary artery are approximately equal Fourth, the cardiac output (reflecting cardiac work) and the volume of flow through the shunt (representing wasted cardiac effort which may eventually produce right heart strain and right heart failure) can be measured Small shunts are better tolerated by the heart than are large shunts, hence it is more imperative to close large shunts than to close small shunts, from the standpoint of longevity

These are the principal types of data to be derived from right heart cardiac catheterization Left heart catheterization has been frequently performed by means of inserting a fine catheter through a needle passed through the left main stem bronchus (at bronchoscopy) and into the left atrium The needle has also been passed through the posterior chest wall However, the data thus obtained are not yet as helpful as are those obtained by right heart catheterization, particularly as regards pressure measurements A particular value of left atrial pressure measurements lies in the detection of mitral regurgitation preoperatively

To summarize, a precise preoperative cardiac diagnosis is absolutely indispensable for routinely satisfactory cardiac surgery With a poorly placed chest incision and erroneous information regarding the intracardiac pathology, the operation will result in frustrated and ineffectual effort in an inexcusable number of instances Again, the diagnosis is achieved by various combinations of clinical evaluation, the electrocardiogram, roentgenographic studies that may in-

clude angiocardiography, and cardiac catheterization Only occasionally is "exploratory cardiotomy" justified

Preoperative Preparation for Surgery

Once the diagnosis of the heart lesion that is present has been established, the preoperative preparation required follows in an orderly fashion For example, the patient with a patent ductus arteriosus or coarctation of the aorta requires no special preparation, to be sure, adequate amounts of blood must be on hand, a suitable graft should be available, if needed, to bridge the defect produced by excision of the coarcted segment, and the proper special instruments and suture material should be available on the instrument table The position of the aortic arch should be known, of course, for it could be on the right side, in this case a left thoracotomy would be worthless

Now, contrast these simple preparations with those required for open heart surgery, which involves the use of the pump oxygenator *and the several persons who operate this equipment Obviously*, there is a wide range in the preoperative preparation required for the correction of various abnormalities of the heart and great vessels

Only a general outline of the *preoperative preparation required for heart operations* can be given here The details must be suited to the individual patient These general measures are

(1) Establish an accurate diagnosis (see above) Maintain close liaison with medical colleagues
(2) Treat cardiac decompensation
  (a) Digitalis
  (b) Mercurial diuretics
  (c) Limit salt intake
  (d) Bed rest
(3) Contact the anesthesiologist who is versed in the requirements of patient with cardiac lesions
(4) Preoperative orders and other preparation
  (a) Routine (select those applicable p 64)
  (b) Atropine
  (c) Sedation (barbiturate) that is not excessive
  (d) Have adequate amount of compatible blood available Special precautions in infants
  (e) Rehearse mentally the unusual technical problems that may be encountered and the instruments and maneuvers that may be suddenly required to extricate oneself from serious technical difficulties
  (f) Perform a *venous cut down in addition to the usual venipuncture or insert* two Rochester needles (FIG 7) Have at least one infusion in an arm in case

the inferior vena cava should be occluded temporarily in resecting an abdominal aneurysm

(g) Employ a minimum of one competent assistant who fully comprehends the pathology involved the technical and physiologic objectives of the procedure the complications that may develop abruptly and the means of dealing with these complications This assistant may be required to do a crucial part of the operation under some circumstances

(h) Check the suture nurse s instrument table at the beginning of the operation so that the missing pedal clamps can be located and sterilized while the routine of opening the chest is proceeding For once the patient is under anesthesia success is enhanced by expeditious surgery though meticulous dissection and anastomoses are not to be sacrificed in the pursuit of precipitous haste A well done technical procedure is the keystone of success a poor technical performance cannot be altered by any postoperative measures that can be conceived Thus delicacy or gentleness precision and operative familiarity with the heart lesion and the problems involved go far toward achieving physiologic success and patient rehabilitation

Beyond these general comments one enters the field of the technic, variations hazards and the special factors involved in the successful surgery of the many different heart lesions Such problems are beyond the scope of this small volume It is sufficient to state that the complications of pulmonary resection operations upon the chest wall the proper use of vessel grafts the technic of vascular anastomosis a practical familiarity with cardiopulmonary physiology the perception of what instrumentation will be most applicable the technic of hypothermia the use of the pump-oxygenator and the use of pressure measurements during operation are some of the types of specialized information which the cardiac surgeon must have acquired

Postoperative Care

If the lesion has been adequately corrected, the postoperative care may be relatively straightforward General measures include

(1) Those listed for pulmonary resection (referable to providing good pulmonary ventilation)
(2) Oxygen therapy
(3) Avoid excessive infusion of blood or other fluid
(4) Continue efforts to prevent infection (a real hazard in the presence of vascular suture lines)
(5) Continue digitalis if indicated
(6) Early ambulation as compatible with the specific operation

ESOPHAGEAL RESECTION

The complications of esophageal resection are fairly common and are disproportionately formidable resulting in considerable mor-

bidity and a significant mortality rate Nevertheless, the procedure of esophagectomy is basically a simple one It is principally the precarious blood supply of the esophagus that permits a postoperative fistula to develop, assuming that a careful anastomosis was performed The resulting mediastinitis with empyema constitutes the major complication that may develop

Diagnosis

The single most important symptom which prompts the patient with esophageal disease to seek surgery is *dysphagia* This may present in the form of discomfort or actual pain long before food fails to pass into the stomach especially in the case of carcinoma Thus, difficulty on swallowing leads the patient to consult his physician, and a barium swallow reveals suggestive evidence of one of the several surgical lesions of the esophagus smooth benign stricture, ragged malignant stricture, smooth filling defect representing leiomyoma or lipoma, achalasia diverticulum, peptic esophagitis or hiatal hernia Following the availability of what information can be gained from roentgen studies, esophagoscopy is indicated in most patients One may visualize inflammation or ulceration, and he can biopsy lesions which may represent tumor

Let us suppose that a squamous cell carcinoma, situated in the lower third of the esophagus, has been proved by biopsy in a patient who has lost 40 pounds What preoperative preparation is required? (Malignant lesions of the upper half of the esophagus are now usually treated with radiation therapy)

There are two methods for improving the capacity of the debilitated patient to withstand lower esophageal resection with esophago-gastric anastomosis The first consists of the liberal transfusion of blood until the hemoglobin and hematocrit levels are within normal limits The second consists of passing a polyethylene tube through the malignant stricture at esophagoscopy and by this means feeding the patient for perhaps 10 days prior to surgery, again with the liberal use of blood transfusion We prefer to pursue aggressive realimentation in these patients whenever this is possible, but often the more practical course is to restore the red cell mass and total blood volume to normal levels with transfusion and then to operate promptly Once the obstruction in the alimentary tract has been removed surgically, nutritional rehabilitation may proceed expeditiously

Operation

With the patient on his right side, a left thoracotomy incision is made at about the level of the seventh intercostal space, and the esophagus is approached through the mediastinal pleura A point well above the tumor (at least 5 cm) is selected for the site of subsequent anastomosis, and hernia tape ligatures are secured immediately above and below the tumor to minimize seeding of the subsequent anastomosis with loose tumor cells The esophagus with its areolar tissue and lymph nodes is then dissected free of surrounding structures The diaphragm is opened from the left dome downward to the esophageal hiatus, if preliminary manual exploration of the upper abdomen through a small incision has not indicated metastases which preclude even palliative esophageal resection The dissection is continued along the greater and lesser curvatures of the stomach as many lymph nodes being included in the *en bloc* dissection as possible The left gastric artery is identified and usually divided The marginal (gastroepiploic) artery along the greater curvature is carefully preserved but the spleen and adjacent omentum are removed If the lesion is not adjacent to the stomach it may not be necessary to excise a portion of the stomach, but even in these cases we usually divide the stomach between clamps at a level approximating the junction of the fundus and cardia with the body of the organ Actually as much stomach is removed as conveniently can be, to reduce the postoperative hazard of peptic esophagitis due to the effect of the acid-pepsin factor Vagotomy is of course effected when the esophagus is divided The portion of the stomach extending along the lesser curvature is then closed and the stoma remaining adjacent to the greater curvature (or a separate one made for the purpose) is then advanced and anastomosed to the esophagus at the point selected above the carcinoma in the chest This anastomosis is the most critical feature of the operation, for leakage at the site of anastomosis is the major cause of late postoperative morbidity and mortality Two rows of interrupted silk sutures are used The mucosa is the strongest layer of the esophagus and it should be securely joined to the stomach at all points and the mucosa of both the stomach and the esophagus should be inverted Following completion of the anastomosis over the Levin tube, the stomach is secured to the surrounding pleura with interrupted silk sutures to prevent tension on the anastomosis The esophagus is

molested as little as possible above the site of anastomosis, lest its *segmental type of blood supply be further disturbed* The posterior row of sutures is usually placed before the esophagus is completely divided

The adequacy of the esophageal resection should be checked with frozen section, since esophageal carcinoma often spreads for some distance beneath the apparently normal mucosa Unless this is done the pathologist will all too often report that the tumor was incompletely excised at the upper margin The sponge count is now taken (to avoid leaving a sponge below the diaphragm) the diaphragm is closed around the stomach, the hemithorax is thoroughly irrigated with saline to remove as much contamination as possible, and the chest is closed with a single tube for drainage Antibiotics (penicillin 1 000,000 units streptomycin 1 Gm) are instilled into the hemithorax, and are given postoperatively

Postoperative Care

The postoperative care usually presents few special problems if meticulous surgery has been performed in a reasonably well prepared patient As stated, the most feared early complication is leakage at the site of the anastomosis, and this will not occur until a number of days have elapsed Meanwhile, chest films will be taken to confirm expansion of the left lung and the adequacy of pleural drainage by means of the thoracotomy tube We leave the Levin tube in the stomach for 48 hours so that overdistention of this organ can be prevented The risk of respiratory embarrassment and cardiac arrhythmia in these often elderly patients is thus reduced, we believe *If arrhythmias do develop digitalization may be indicated* Transfusions are given as necessary (See also pulmonary problems p 115)

Leakage at the site of the anastomosis may occur slowly and permit time for inflammation and fever to develop, though pain may be the initial warning sign However massive leakage of gastric juice can produce circulatory collapse which may prove surprisingly refractory to treatment When leakage occurs, adequate tube drainage must be established at once If the original drainage tube is still in place and open it may suffice Otherwise, a new tube must be inserted As a rule an immediate secondary operation is not attempted in these patients, yet we did re-explore one patient who

leaked following lower esophageal surgery, and after closure of the defect by sutures her recovery was uneventful

As for feeding, the nasogastric tube is usually withdrawn on about the second or third postoperative day and liquids are started by mouth Thereafter, the diet is steadily increased in consistency and in volume Late complications involve poor gastric emptying due to functional or organic pyloric obstruction, stricture at the anastomosis and distant metastases from the tumor In addition, the reflux of acid gastric juice may produce a distressing esophagitis with erythema and even ulceration, this despite the fact that the vagi were divided in the course of esophageal resection and that at least a segment of the acid-bearing portion of the stomach was removed Medical measures directed toward reduction of the gastric acidity plus esophageal dilatation as required, usually will control the esophagitis and the anastomotic stenosis fairly well Nevertheless when little or no stomach was resected to reduce gastric acidity in the patient with a normal or elevated rate of acid secretion the inflammation of the lower esophagus can be an extremely distressing problem for both the patient and the surgeon

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12 *The Arteries and Veins*

DISEASES OF THE LOWER AORTA AND PERIPHERAL ARTERIES

THE CONDITIONS of the abdominal aorta and peripheral arteries for which surgery is most often required can be grouped into four categories (1) *aneurysms*, (2) *occlusive disease* (atherosclerosis, thrombosis, embolism), (3) *spastic diseases*, often with an inflammatory occlusive element (Raynaud's disease, Buerger's disease), and (4) *traumatic injuries*, with or without arteriovenous fistula The general preoperative, operative, and postoperative measures required are similar for these several conditions, with the possible exception of the spastic phenomena for which lumbar or cervical sympathectomy may be indicated Thus, the management of these several pathologic states will be outlined in an all inclusive fashion, with specific requirements noted where applicable

Preoperative Measures

Diagnosis

(1) *History*

(a) Spasm with ischemia (Raynaud's disease)

(b) *Intermittent claudication in the legs perhaps associated with impotency or* rest pain (thrombotic or atherosclerotic occlusive disease)

(c) Sudden or more gradual onset of pain numbness or paralysis in legs of patient with atrial fibrillation or recent myocardial infarct (embolism)

(d) Pulsating mass in the abdomen often associated with pain in the back (aneurysm)

(e) Injury to extremity followed by profuse arterial hemorrhage (artery severed?) pulsating hematoma (false aneurysm due to hole in artery) or a thrill (arteriovenous fistula)

(2) *Physical Examination*

(a) *Inspection* Evidence of acute or chronic ischemia as indicated by pallor cyanosis or trophic changes of feet which include loss of hair nail deformities shiny and thin skin and reduced volume of pulp of the toes Swelling due to hemorrhage or edema in the tissues of the part

(b) *Palpation* (FIG 30) Check aortic (deep compression above umbilicus) iliac (deep compression along its course) femoral popliteal and foot *pulses* Occlusion of hypogastric arteries may give buttock and thigh symptoms when all usually detected pulses are present and of fair volume *Temperature* of two legs at comparable levels (cold in ischemia warm in presence of A V fistula) *Thrill* over partially occluded femoral artery or over an A V

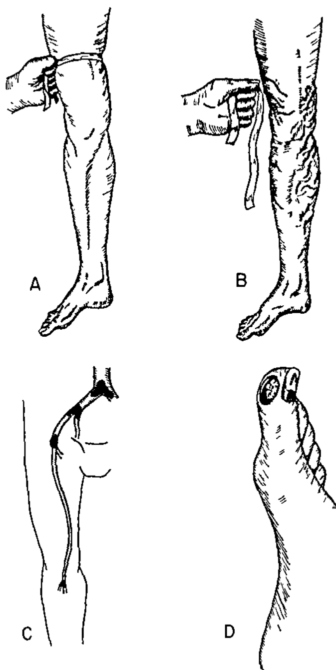


FIG 30—(A) Long saphenous vein occluded by tourniquet after leg was previously elevated to empty veins (B) Tourniquet abruptly released demonstrating immediate retrograde filling of the long saphenous because of incompetent valves (C) Arterial occlusion by embolus or thrombus is particularly apt to occur at bifurcations (D) Ulcer on great toe may signify advanced generalized atherosclerosis diabetes mellitus with atherosclerotic component Buerger's disease or neurologic deficit ("tropic ulcer")—among other more rare conditions exclusive of trauma and neoplasm

fistula with slowing of heart rate on occlusion of defect by firm digital point pressure

(c) *Auscultation* Systolic bruit ("murmur") over a partially occluded artery over a false or true aneurysm at times and usually a continuous sound over the A V fistula

(3) *Laboratory and Roentgen Studies*

(a) Routine including blood serology

(b) Tests to evaluate spastic element (paravertebral sympathetic block or cervical sympathetic block)

(c) Aortogram or arteriogram

(d) Plethysmographic oscillometric or skin temperature values (none used routinely)

(4) *Exclude other lesions* i e cervical rib or scalenus anticus syndrome in arm ruptured intervertebral disc or nerve lesion causing pain in back or extremities or abscess in suspected pulsating hematoma

Measures Required Immediately Before or During Surgery

(1) Short or long tube for alimentary decompression in aortic surgery Reefing of the small bowel on the long tube may facilitate exposure but may produce intussusception in the occasional case when the tube is withdrawn postoperatively

(2) Catheter for bladder decompression to improve exposure in pelvis

(3) Adequate amounts of compatible blood for the operation contemplated

(4) Suitable prosthesis or homograft available

(5) Pneumatic tourniquet if needed

(6) Proper vascular instruments for maneuvers envisioned

(7) Adequate facility of operator in managing hemorrhage from large vessels and in performing vascular anastomoses (gained in animal laboratory)

(8) Avoid precipitation of gangrene in an extremity which patient could use effectively preoperatively (by ill conceived technical maneuvers unessential arteriograms with concentrated contrast medium etc)

(9) Debride and drain traumatic injuries associated with hematoma and muscle damage

(10) Aneurysm may obscure position of ureters vena cava or iliac veins Care required

(11) Radiologist available for indicated arteriograms on operating table

Postoperative Considerations

(1) Routine orders (p 65)

(2) Watch for further hemorrhage (uncommon if pathology adequately dealt with)

(3) Check pulses color warmth sensation and ability to move the extremities Pulses present immediately following surgery may disappear later in day if leg and foot pain remain obviously viable one may temporize for absent pulses may reflect arteriospasm which will subside However if the leg or foot is cold pale numb and cannot be moved by the patient suspect occlusion at anastomosis and consider re-exploration

(4) Bed patient on day of surgery up the next day if circulation stabilized and not otherwise contraindicated

(5) Antibiotics as prophylaxis against infection around graft or other suture line which might permit fatal hemorrhage
(6) Wound separation partial or complete with evisceration is not rare following resection of the abdominal aorta
(7) Urinary output important especially if aorta temporarily occluded above renal arteries or if significant periods of hypotension have occured (oliguria or anuria)
(8) Bladder dysfunction may require continued use of Foley indwelling catheter for a number of days
(9) Gastric retention and/or ileus may increase the morbidity Long tube suction
(10) Colon ischemia rare but occasionally a result of ligation of the inferior mesenteric artery and both hypogastrics may be reflected in diarrhea or in passage of a slough of mucosa or in gangrene with perforation and peritonitis
(11) Amputation of an extremity should surgery not improve pre-existing ischemia is best carried out after the patient has been prepared for it emotionally
(12) Other occasional complications retroperitoneal hemorrhage (heparin a hazard) hemiplegia heart failure thrombosis of superior mesenteric artery and pulmonary embolus The older the patient the more important it is to do the least amount of dissection and other manipulation compatible with satisfactory results

Comment on Aortic and Peripheral Arterial Surgery

In few areas of surgery are experience, careful preparation, and precise technic more rewarding than in that concerned with operations on the abdominal aorta and its major subdivisions End-to-end anastomosis, with preservation of the lumen, results in good blood flow (in an otherwise normal outflow tract), and complications of a well performed vascular anastomosis in a clean field are few indeed Again, the essential factors in successful vascular surgery are accurate diagnosis, accurate understanding of the anatomy, pathology and pathophysiology involved, experience in vascular suturing (readily obtained in dog lab), and precise correction of the defects found at surgery In occlusion of the aorta or iliac arteries one can often *perform successful endarterectomy*, excision with grafting or *bypassing*, segmental occlusion of the femoral artery is best treated with a bypass Aneurysms are resected and a graft or prosthesis inserted Arterial injuries respond quite well to primary anastomosis An arteriovenous fistula can often be excised and arterial anastomosis performed without the use of a graft or prosthesis However, these should be available in the event that the ends of the divided artery cannot be approximated for suture without excessive tension

DISEASES OF VEINS

The venous conditions which require surgery are usually varices or thromboses Phlebitis is associated with varying degrees of venous occlusion Arteriovenous fistula was mentioned previously

Varicose Veins

Causes The average patient may present few factors to which the varicosities can be attributed Heredity, obesity and long hours of standing have been cited Pregnant women commonly exhibit varices and hemorrhoids and here both pressure and hormonal factors may be implicated Superficial varices may reflect deep vein thrombosis or an arteriovenous fistula

Preoperative Measures

(1) Diagnosis
  (a) Extent of venous pathology
  (b) Short saphenous vein involved?
  (c) Deep veins occluded? (Test with tourniquet around upper thigh or with venograms where indicated the medium being injected into a dorsal vein of the foot in presence of occluding venous tourniquet above ankle)
(2) Identify and mark (with paint which will not be washed off with the prep or with scratch mark of a pin) the important varices which will not be managed merely by saphenous ligation and stripping The e separate le ions often require short separate inci ions Particular care should be taken to mark al o even small varices which are especially offen ive to the patient
(3) Explain to patient (1) that not every single small varix will be removed (for otherwise an exces ive number of incisions would be required) (2) that re idual varices still pre ent after three months may be injected and (3) that the inherent tendency to form varices will not be aboli hed by operation though the process will be retarded by ligation and stripping

Operative Considerations

(1) An *incision* below but parallel to the inguinal crea e heals with a le s noticeable scar The hort vertical incision gives better access to the descending long saphenous vein for stripping following ligation and division of this vein at the fossa ovalis where it joins the femoral vein
(2) *Lymphatic channels* hould be avoided (or ligated) in expo ing the vein To sever these vessels is to invite a prolonged drainage of lymph through the incision postoperatively
(3) *Tributaries* to the upper saphenous vein should be meticulously identified ligated and divided *Recurrence* often con i ts of veins that were never ligated at the initial operation
(4) The *proximal stump* of the saphenous vein should be securely ligated to prevent postoperative hemorrhage The *femoral vein* must be identified or at least not occluded (One must inci e fa cia to expose the femoral vein whereas the saphenous vein is ubcutaneous—but mistaken identity is not rare)
(5) The *stripper* is be t pa sed from below upward after in ertion into the lower

end of the long saphenous vein through a short incision just anterior to the medial malleolus

(6) *Immediate compression* along the course of the stripped long saphenous will reduce hematoma formation Several separate short transverse incisions may be required for ligation of communicating branches which successively arrest the stripping process

(7) Finally the *short saphenous* entering the popliteal space and other isolated varices may require ligation

Postoperative Care

(1) *Elastic bandages* are applied over the dressed wounds from the toes upward to the groin These are removed and reapplied as often as necessary to maintain proper positioning (usually once or more daily)

(2) *Ambulation to a degree but with limitations* Pain and soreness in the legs result in limited activity for most patients for several days Excessive standing or walking immediately following operation will increase edematous swelling of the legs

(3) *Diet* as desired post nauseam

(4) *Wounds dressed* on fifth P O D and all sutures removed if healing progressing satisfactorily Discharge with follow up in office

(5) *Elastic stockings* should be worn for support if there is considerable edema of the leg or if a varicose ulcer was threatening prior to surgery

(6) *Prolonged follow up* of patients with potentially progressive venous (and other vascular) disease is highly desirable to (1) know the results of treatment (2) encourage the patient with chronic disease and (3) anticipate further progression or complications such as ulceration

Other Venous Diseases

Venous *thrombosis* and venous *inflammation* usually occur together, though one or the other may predominate in the given case For example, phlebothrombosis with a "bland" thrombus may be associated with little evidence of acute inflammation initially, in fact, the absence of an adherent inflammatory reaction is considered to be the reason why pulmonary embolism is far more likely to occur in "phlebothrombosis" than in "thrombophlebitis" Some have advocated surgical removal of these clots, but most often phlebothrombosis is treated with anticoagulants, ligation being rarely employed In contrast, acute thrombophlebitis involving the deep femoral vein may give rise to a marked systemic febrile reaction, though months later only pain and ulceration of the lower leg (*postphlebitic syndrome*) may remain to attest the former presence of the acute inflammatory process In general, thrombosis and inflammation of *superficial* leg veins and of *all* arm veins, do not constitute a serious problem, but disease of the deep veins of the leg can constitute a very serious one

Ulceration of the lower leg is ordinarily treated by division and stripping of obvious varicose veins, followed by conservative measures which include elastic bandages, an elastic stocking or a gelatin (Unna paste) boot However, when the ulceration is clearly secondary to deep vein thrombosis (often it is secondary to no discernible cause) many surgeons prefer to ligate the superficial femoral vein and then to excise the ulcer and all surrounding abnormal skin, down to the fascia, the defect is then covered with a split thickness skin graft This treatment works fairly well in some patients but, should the graft fail to take or subsequently break down, one may be confronted with a far larger ulcer (due to excision of the surrounding diseased skin with the original ulcer) than was present preoperatively Since poor lymphatic drainage has been implicated as an etiologic factor in stasis leg ulcers, it has been suggested that the extent of superficial skin lymphatic blockage be outlined by the injection of sky blue dye (Wyeth) intradermally Our experience with this technic has not been a conspicuously successful one, and we have depended upon our clinical impression as to the extent of the diseased skin

It has been claimed that ulcer recurrence is due to the failure to excise all diseased skin, but we doubt this Chronic stasis leg ulcers may defy specific etiologic explanation and even the most heroic therapy (the election of which does not always constitute good judgement, in our opinion) may fail to deal with the ulcer satisfactorily

Following ulcer excision and grafting, the patient must remain at bed rest until the skin graft has clearly healed Moreover, if on arising small hemorrhages "blisters" or areas of necrosis appear beneath or in the graft, bed rest should be resumed until the upright position can be tolerated without acute deterioration of the graft Following this an elastic stocking is worn indefinitely, and activity is permitted to the extent which the graft will tolerate without breaking down

Unfortunately, by no means do all ulcers that are excised and grafted remain healed What happens to these patients? They carry on according to their situation in life and personal stamina The wealthy person who can remain off the leg when recurrent break down threatens will have less recurrent ulceration than the day laborer who must work regardless And yet, we treated a 70

year old man (who had worked and reared a family) with a large lower leg ulcer that had constantly been present since he was a boy in his teens. He refused any operation, inasmuch as limited excision and grafting 20 years previously had been followed promptly by breakdown of the graft when he was allowed out of bed three weeks following surgery.

The *inferior vena cava* is occasionally ligated for persistent pulmonary embolization from more peripheral veins. However, one should first be certain that anticoagulants will not control the process, for ligation of the inferior vena cava can result in severe and prolonged postoperative morbidity due to swelling of the legs, with or without the precipitation of actual ulceration. The vena cava may be approached retroperitoneally through a transverse lower right abdominal or flank incision, or it may be approached transperitoneally through a midline abdominal incision. The origin of the inferior vena cava and the bifurcation of the aorta are both situated approximately beneath the umbilicus. Having used each of the above two operative approaches, the writer prefers the direct transperitoneal approach. The vena cava is ligated with ligatures of large diameter chromic catgut or silk, or perhaps preferably, hernia tape. There is usually a sharp drop in blood pressure as the vena cava is occluded, and blood should be on hand for transfusion. However, the hypotension is usually brief and thereafter circulatory stability is generally satisfactory.

Again, ligation of the inferior vena cava can result in such prolonged morbidity due to swelling of the legs that it should be strongly resisted except where required to save the life of the patient by preventing further embolization, whether septic or nonseptic.

Thrombosis or *compression* of the inferior vena cava may be due to neoplasm, aneurysm, massive ascites, large cyst, abscess or extension of thrombus from iliac veins.

The *superior vena caval syndrome* due to external compression or thrombosis of the superior vena cava may be treated successfully with surgery (bypassing with graft) in isolated instances. More often, though, the cause is inflammatory or neoplastic and roentgen therapy or appropriate antibiotics are more efficacious. Since a neoplastic process producing caval obstruction is rarely eradicated, the major therapeutic objective is that of reduction of the edema

and other symptomatology that are the result of impaired venous drainage of the upper half of the body

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13 *The Acute Abdomen*

THE GENERAL SURGEON is so often concerned with the patient who has undiagnosed intra-abdominal pathology that special consideration will be accorded the "acute abdomen" By and large, the issues to be decided resolve themselves into the usual ones in other fields of surgery (1) that of making a diagnosis, (2) that of deciding whether or not surgery is required and, if so, (3) what procedure is indicated and (4) when it should be performed

MAKING THE DIAGNOSIS

It is often stated that it is less essential to establish an accurate diagnosis than it is to decide whether or not an operation is required In other words, the precise diagnosis can be ascertained after the abdomen has been opened, the important thing is not to fail to operate when without an operation the patient's recovery will be greatly jeopardized

While there is much practical truth in this point of view, it at the same time tends to promote a less careful and critical analysis of all the information available In our opinion, it fosters a less mature intellectual and disciplined approach to surgical care, with an inevitable decline in the ultimate quality of practice For instance, a ruptured abdominal aneurysm certainly causes an "acute abdomen" that obviously needs to be explored, but an accurate preoperative diagnosis will improve the quality of this particular patient's operation While at times it is impossible to reach a more presumptive preoperative diagnosis than that the patient has sustained a perforation of a hollow viscus, the accuracy of preoperative diagnosis should be carried as far as time, resources and practical considerations permit This requires due attention to the clinical examination and to laboratory and roentgen studies

One valuable training requirement is to insist that the members of the operating team write down their diagnoses on the chart prior to surgery Another important factor in promoting more careful preoperative diagnosis is an active *tissue committee*

The History

In few other circumstances is an accurate history of more diagnostic assistance than in connection with the acute abdomen This is because most of the more common diseases begin and progress with rather characteristic constellations of symptoms (FIG 31) Furthermore, *the common diseases are manifestly those usually encountered*, that is, although the rare conditions should be thought of eventually, it is the common lesion such as appendicitis that should be thought of first The time of onset (day, night, before a meal, after a meal, etc), whether anorexia is present, gas stoppage, nausea and vomiting presence and type of pain—all of these symptoms should be asked about and carefully weighed Next, the manner of the progression of symptoms is important The acutely inflamed appendix, the urinary calculus, the perforated peptic ulcer or the acutely inflamed gallbladder each causes fairly typical symptoms and while they often overlap, the experienced clinician can usually differentiate between them solely on the basis of history and physical examination In women it is especially desirable to inquire regarding the menses, for the ruptured ovarian follicle (mittelschmerz) or the ruptured ectopic pregnancy may be thus suspected

Patients with acute alimentary diseases, including appendicitis, are not often hungry, whereas those with gynecologic conditions frequently are

A history of previous attacks of a similar nature can be most revealing (1) Patient was treated for a duodenal ulcer (2) Housewife was told by a doctor that she had gallstones (3) Recurrent attacks of renal colic with passage of stones (4) Prior attacks of what may have been appendicitis (5) Intermittent partial intestinal obstruction in the past

Once the *history of the present illness* has been thoroughly explored, the *systemic review* and *past medical history* should be used as a safeguard against the failure of the patient to bring up important points bearing upon the possible etiology of the present illness—as, for example, the information concerning a previous abdominal operation that may have been performed for cancer or may now be causing intestinal obstruction due to adhesions

So much for the history Not all contingencies can be covered, but a few useful relationships are noted in FIGURE 31

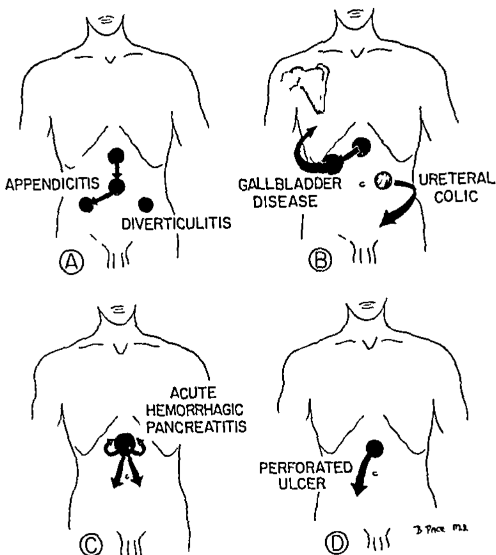


FIG 31—The pain pattern with associated physical findings is often virtually diagnostic in these common examples of intra abdominal disease

The Physical Examination

Inspection, palpation and *auscultation* are here the important elements *Percussion* aids in confirming the presence of an enlarged liver, or distention due to gas or to fluid

Inspection may reveal whether or not the patient appears acutely ill or in pain, the presence of jaundice, anemia, dehydration, weight loss, whether or not the abdomen is distended, the presence of visible peristalsis and the position in bed Fecal vomitus suggests intestinal obstruction, copious watery vomitus suggests pyloric obstruction, especially if it contains no bile (shake bottle for foam)

Palpation may reveal tenderness, muscle rigidity (voluntary or involuntary) or masses In general, rebound tenderness suggests irritation of the parietal peritoneum Noninflammatory masses are often movable and usually nontender Inflammatory masses are ill defined, fixed and characteristically tender

Auscultation is especially valuable in determining the quality and quantity of peristalsis A "silent abdomen" on admission suggests the possibility of peritonitis with ileus, or paralytic ileus due perhaps to renal stone or retroperitoneal hemorrhage Borborygmus and/or tinkling (high pitched) peristalsis suggests the presence of mechanical intestinal obstruction, and this should be further investigated by radiologic studies

Rectal and *pelvic* examinations are never omitted by the experienced surgeon Are there extraluminal or intraluminal masses which may represent tumor metastases? Vaginal discharge or parametrial tenderness to indicate pelvic inflammatory disease? Tenderness high on right (appendicitis?) or on left (diverticulitis?)? Blood on gloved finger? These and other clues may be discovered on rectal and vaginal examination

Laboratory Studies

Blood Count and Urinalysis The history and physical examination will have indicated whether or not special studies are in order, but the importance of the ordinary blood count and urinalysis is often marked The normal total white count at least lends reassurance during a trial of conservative management, even if it does not always exclude acute inflammatory disease The presence of anemia in a Negro should bring to mind the possibility of sickle cell disease Porphyria may exist A low platelet count (on gross estimation from the smear) may lead to further study to exclude spontaneous hemorrhage or leukemia A rising total white count frequently prompts surgical intervention

The urinalysis can also be of crucial significance Of course most of the time it is negative, there is no albuminuria, glycosuria, hematuria or pyuria Yet in the occasional case it proves worth all the negative studies We are reminded of a 9 year old girl the daughter of a close friend whose parents had brought her to the emergency room at night repeatedly for abdominal pain which seemed most likely due to mesenteric adenitis The white cell count and urinalysis were always essentially normal Finally, though,

it was decided that if she had another attack we would perform an appendectomy A night or so later another attack of abdominal pain occurred and admission for appendectomy was arranged forthwith However the "routine urinalysis" report, returned shortly before the time scheduled for surgery, revealed large numbers of white and red blood cells The child had pyelonephritis The operation was cancelled

On many other occasions the presence of hematuria has led to roentgen demonstration of urinary tract calculi

Serum Amylase In any patient with pain in the upper abdomen a determination of the serum amylase level may reveal pancrea-

TABLE 15—*Some Conditions which Cause Abdominal Pain**

1 MORE COMMON ACUTE ABDOMINAL CONDITIONS REQUIRING IMMEDIATE OR EARLY SURGERY
   a Acute appendicitis
   b Acute cholecystitis (short delay permissible)
   c Intestinal obstruction—check for hernias
   d Perforated viscus—duodenal ulcer most common
   e Massive hemorrhage—spleen ruptured ectopic pregnancy
   f Strangulated hernia
   g Twisted ovarian cyst—rapidly increasing mass
   h Mesenteric vascular occlusion
   i Acute peritonitis due to diverticula—Meckel s etc
   j Penetrating wounds—always explore *definitely penetrating* wounds
   k Severe closed trauma—needs careful evaluation

2 BORDERLINE CASES—BETTER NOT TO OPERATE IF DIAGNOSIS CAN BE MADE BUT BETTER TO GO AHEAD THAN RISK DEVELOPMENT OF COMPLICATED DISEASE
   a Mesenteric lymphadenitis
   b Pelvic inflammatory disease—acute salpingitis
   c Ovulatory pain—mittelschmerz
   d Acute gastroenteritis or enterocolitis
   e Early stages of acute exanthematous disease

3 THOSE WHERE NONOPERATIVE TREATMENT DEFINITELY INDICATED
   a Paralytic ileus
   b Acute pancreatitis
   c Renal colic
   d Urinary retention
   e Acute hepatitis

4 ABDOMINAL SYMPTOMS WITH MORE REMOTE CAUSES—OPERATION CONTRAINDICATED
   a Coronary occlusion—ECG
   b Pneumonia pleurisy—chest x ray and examination
   c Hepatomegaly—due to congestive heart failure
   d Abdominal pain in sickle cell anemia—young Negro males
   e *Abdominal pain in lead poisoning*
   f Arachnoidism—history of possible spider bite
   g Abdominal pain in malaria and typhoid fever—high fever out of proportion to abdominal findings
   h Porphyria—Watson Schwartz test
   i Periarteritis nodosa
   j Dissecting aneurysm (Operate?)
   k Abdominal pain with herpes zoster—pain precedes the rash
   l Spontaneous pneumothorax
   m Luetic crises
   n Tick bite phenomena

* Modified from Dr George E Gillespie

titis This disease is very common, and the frequency with which it is detected is related to the number of amylase measurements requested (though other conditions may cause the level to rise)

Roentgen Studies

Intelligently used x-ray examinations can be extremely valuable in the diagnosis and subsequent evaluation of certain types of acute abdominal disease

Plain Film of Abdomen This study is especially to be ordered when cramping abdominal pain and other findings suggest the possibility of intestinal obstruction, or when signs of peritonitis suggest the possibility of a ruptured hollow viscus, or when gall bladder or urinary calculi may be present Actually, the biliary calculi are radiopaque in only about 15 per cent of cases, whereas urinary calculi are radiopaque in about 85 per cent of cases *The presence of exudate or ascites may be detected between loops of* gas-filled bowel Free air in the peritoneal cavity usually has been derived from the rupture of a hollow viscus The ruptured peptic ulcer is the most frequent source, but perforation of the colon must be considered, rarely is free air due to perforation of previously normal small bowel Abscesses, tumors or cysts may have displaced kidney spleen, liver or colon, and infection may have obscured the psoas shadow The ruptured abdominal aneurysm may be detected by a thin rim of calcium in the wall of the lesion Air in the gall

ACUTE APPENDICITIS	APPENDICEAL ABSCESS	WIDESPREAD PERITONITIS
Tenderness	Firm mass walled off	Distention
PROMPT APPENDECTOMY	MANAGE CONSERVATIVELY	MANAGE CONSERVATIVELY
	Drain abscess if no improvement	Treat peritonitis and complications
	Interval appendectomy	Interval appendectomy

FIG 32—Patients admitted late with a walled off appendiceal abscess generally do well on conservative management At interval appendectomy performed from 6 to 8 weeks later little evidence of the previous suppuration may be found Conservative management of peritonitis consists of gastrointestinal suction intravenous fluid and blood massive antibiotics (penicillin streptomycin usually) and bed rest with sedation as indicated

bladder may be due to a cholecystoenteric fistula, and the mechanical small bowel obstruction may represent gallstone ileus

Emergency Intravenous Pyelogram This study is often diagnostic when a ureteral stone is suspected on clinical grounds but cannot be detected on the plain film of the abdomen

Other Special Roentgen Studies At various times an emergency aortogram (for suspected aneurysm), barium enema (to exclude colon obstruction), or upper gastrointestinal series with thin barium may be indicated

MANAGEMENT OF THE ACUTE ABDOMEN

Having made the diagnosis, the proper management usually poses no great problem in most cases In TABLE 15 are listed diseases which generally require immediate surgery those which may not require surgery and ones in which surgery is definitely contraindicated as an emergency measure

Assuming that surgery is to be performed as soon as possible, the following measures are considered

(1) Routine preparation (p 64)
(2) Intravenous fluids if needed
(3) Ensure an empty stomach during anesthesia induction
(4) Nasogastric tube required in many patients
(5) Antibiotics?
(6) Transfusion indicated prior to or during surgery?

Postoperatively the treatment will depend on the condition found at surgery and the procedures carried out The simple appendectomy (FIG 32) requires only routine orders (p 64) The patient who had intestinal obstruction an abscess with peritonitis or an acutely inflamed gallbladder for which cholecystectomy was performed will benefit from continued nasogastric suction in most instances Intravenous fluids, nothing by mouth and an intake-output record should be instituted Any drains placed at surgery should be shortened progressively and the abdominal sutures removed at the appropriate time

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2 REQUARTH W Diagnosis of Acute Abdominal Pain Chicago Year Book Publishers Inc 1953
3 ZWALENBURG C VAN The relation of mechanical distention to the etiology of appendicitis Ann Surg 41 437 1905

14 *Operations on the Stomach and Intestine*

MANY OF THE CONSIDERATIONS mentioned in connection with esophageal resection apply also to the stomach (FIG 33) and intestine All three constitute portions of the alimentary tract, and nutritional deficiencies are common in diseases involving them

GASTRIC RESECTION

Diagnosis of Gastroduodenal Pathology

The *history* and *physical examination* will often have disclosed epigastric pain, anorexia, weight loss, vomiting, an abdominal mass, tenderness, hematemesis or melena in patients with significant gastric or duodenal disease Any one or combination of these symptoms will frequently prove sufficient to lead to further and more precise diagnostic procedures *Gastric analysis* may reveal a high level of gastric acidity that tends to strengthen the diagnosis of peptic ulceration suggested by the symptoms, or, achlorhydria may be found to suggest that the anorexia, pain on eating and weight loss are due to gastric carcinoma Microscopic examination of the material removed at gastric suction may reveal exfoliated tumor cells

The *radiographic study* of the upper gastrointestinal tract may demonstrate ulceration, pyloric stenosis (FIG 34), rigidity of the stomach suggesting linitis plastica, esophageal varices, gastric polyps or other filling defects due to cancer duodenal diverticulum or some other less common lesion Free air in the peritoneal cavity suggests perforation of a peptic ulcer Biliary air suggests a fistula

The radiographic study is the most dependable of the measures employed for the preoperative diagnosis of gastric or duodenal pathology For optimal interpretation the films must be considered in conjunction with the carefully performed fluoroscopic examination, plus the clinical findings

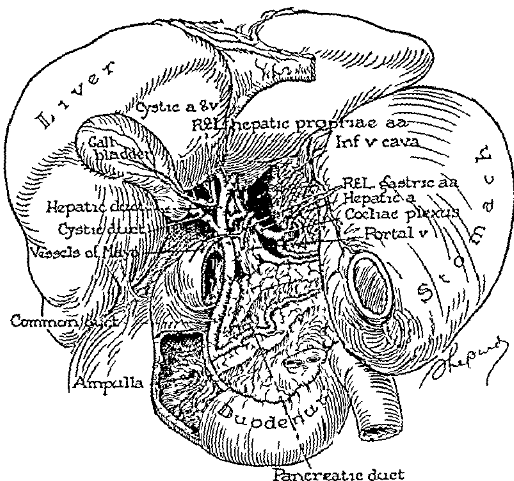


FIG 33—*Surgical Anatomy of the Biliary Tract and Pancreas* (From Oberhelman H A Gall Bladder and Extra Hepatic Bile Ducts *In* Partipilo A V Surgical Technique and Principles of Operative Surgery Philadelphia Lea & Febiger 1957)

Gastroscopy is uncommonly used It is often negative even when pathology is present, and the interpretation of what is seen may be erroneous Furthermore, when a definite diagnosis can be made at gastroscopy, the same information is usually available on the x-ray films

Preoperative Preparation

Assuming that pyloric obstruction probably due to a chronic duodenal ulcer with scar contracture, has been demonstrated, what measures are required to prepare the patient for surgery?

First is the patient in *fluid and electrolyte imbalance* because of the vomiting that has occurred? If he is in metabolic alkalosis due to a loss of chloride and potassium and in dehydration from



Fig 34—*Pyloric Obstruction* This is perhaps the commonest cau e of severe electrolyte derangement met in surgical practice Metabolic alkalosis is reflected in a low plasma chloride level high CO_2 and often a degree of hypokalemia and hypo natremia—resulting in hypotonicity in the already depleted interstitial and plasma fluid volumes Unless actual alkalotic tetany is present which would require intra venous NH_4Cl or HCl adequate amounts of NaCl KCl and water will permit renal correction of most acid base o molar and volumetric deficiencies

water loss, reparative therapy is indicated Moreover, since pyloric obstruction does not constitute a surgical emergency, several days may be allowed for fluid replacement therapy (p 13) and for gastric suction to prevent gastric retention and *thus reduce the edema in the wall of the stomach*

Second *blood transfusion* may be required Actually, blood transfusion, plus adequate water and electrolyte therapy, comprise the principal nutritional measures that can be offered these patients Oral intake is contraindicated intravenous feeding is rather impracticable and jejunostomy is usually not necessary Actually, with a fully restored blood volume these patients generally withstand gastric resection quite well, and the removal of alimentary obstruction quickly makes genuinely effective oral realimentation possible Of course, vitamins can be given intravenously, and some calories and nitrogen can also be made available in this way (p 26)

Preoperative orders (see also p 64) might include

(1) Recheck blood chemistry measurements
(2) Type and crossmatch for 1000 cc of blood
(3) Continue suction on nasogastric tube
(4) Continue intake-output record
(5) Prepare abdomen from nipples to symphysis pubis
(6) Preanesthetic medication
(7) Send x rays to O R with patient

The Operation Itself

The quality of the gastric resection has much to do with the incidence and severity of the postoperative morbidity The careful ligation of all divided vessels a secure closure of the duodenal stump, the construction of a gastrojejunostomy which has no obstruction of either the proximal or the distal stoma the use of adequate precautions to avoid spillage of gastric or duodenal contents into the peritoneal cavity the avoidance of injury to surrounding pancreas and other structures the removal of sufficient stomach to prevent recurrent ulceration the preservation of enough stomach to render unlikely severe postoperative anemia and nutritional problems—these are contributions which the operator can make toward a smooth convalescence

Postoperative Management

In the absence of complications the usual patient having gastric resection requires relatively little specialized treatment (for routine

orders, p 65) The blood volume and fluid balance must be maintained The nasogastric tube is removed on the first or second post operative day and oral intake is rapidly increased thereafter Unfortunately, complications of various types and severity can, and not infrequently do, follow gastric resection When certain of these occur considerable supportive therapy may be required, for many of the complications which follow gastroduodenal surgery interfere with food intake or with its assimilation in the alimentary tract

Postoperative complications include

(1) *Hemorrhage*
  (a) Immediately following surgery
  (b) Late due to recurrent ulceration
(2) *Jaundice* due to
  (a) Intravascular hemolysis
  (b) Spillage of bile into the peritoneal cavity
  (c) Edema or pancreatitis surrounding the common bile duct Rarely to ductal trauma
  (d) Liver failure
(3) *Gastric retention* due to
  (a) Organic obstruction (technical stenosis edema) of the distal stoma
  (b) Adhesions of jejunum
  (c) Neurogenic syndrome of distal loop
  (d) Surrounding abscess or pancreatitis
  (e) Suture of transverse mesocolon to jejunal loop instead of to stomach in retrocolic anastomosis
  (f) Jejunal intussusception
  (g) Internal jejunal hernia
  (h) Vagotomy effect (where applicable)
  (i) Overdistention of proximal loop
  (j) Electrolyte imbalance (?)
(4) *Proximal loop syndrome*
  (a) Partial or complete obstruction with periodic disgorgement of large amounts of bile-containing material or with duodenal stump dehiscence or gangrene of wall of proximal loop
  (b) Ulceration with pain perforation or hemorrhage
(5) *Blow out of duodenal stump* (see above)
  (a) Usually due to either poor stump closure or to obstruction of the proximal loop or both
(6) *Nutritional problems*
  (a) The dumping syndrome with or without diarrhea
  (b) Weight loss progressing to emaciation and anemia
  (c) Loose stools due to technical error in anastomosing stomach to terminal ileum instead of to jejunum (gastro ileal fistula)
(7) *Abscess formation*
(8) *Recurrent ulceration*
  (a) Marginal ulcer with pain bleeding or perforation
  (b) Gastro-jejuno-colic fistula

Clearly, a gastric resection is not to be performed without sound indications, for the "cure" can at times prove far worse than the disease

Hemorrhage into the stomach immediately following surgery may at times be rather disturbing in view of the volume of blood aspirated through the nasogastric tube, but reoperation is rarely required In contrast, continuing hemorrhage into the peritoneal cavity may force one to re explore the abdomen That such concealed bleeding is progressive is reflected in a rapid pulse, pallor, declining blood pressure, dyspnea and a falling hematocrit as the hours pass The abdomen may become distended, and blood may ooze through the suture line However, a large part of the circulating blood volume can be lost into the peritoneal cavity before marked distention is obvious If repeated transfusion is required to sustain the blood pressure, the wound should be opened and the source of hemorrhage controlled Perhaps the splenic capsule will be found to have been torn, once the liquid blood and clots have been removed and adequate exposure secured However, unligated vessels in the omentum or along the greater and lesser curvatures of the remaining stomach may be discovered

There is no substitute for meticulous hemostasis at any operation, whether thyroid (respiratory obstruction postoperatively), thoracic (hemothorax and atelectasis postoperatively), abdominal (as above) or amputation (poor stump healing)

Late hemorrhage due to marginal ulceration may be managed by transthoracic vagotomy or by further gastric resection, in addition to medical measures

Jaundice following gastric resection is always a bit disconcerting but it rarely is due to technical injury to the common bile duct and it usually clears If this finding appears abruptly after the first few days, along with abdominal pain and evidence of intraperitoneal sepsis leakage at the duodenal stump or the gastrojejunal anastomosis must be considered, and as a rule surgical drainage is required Late jaundice may reflect hepatitis

Gastric retention with persistent vomiting when nasogastric tube suction is not maintained can be most distressing This retention may result from any of the causes given above and it may persist for three weeks or more However only occasionally is reoperation required since with continued gastric suction and support with intravenous fluids the stomal or other obstruction gradually sub-

sides If a swallow of thin barium reveals no organic obstruction, the dysfunction may reflect the "neurogenic syndrome" of the distal loop This atonic or, at times, spastic condition appears to be less common following the Hofmeister than after the Polya modification of the Billroth II type of gastric resection Unrelieved obstruction of the upper jejunum, due perhaps to adhesions, will at times necessitate operative intervention

The *proximal loop syndrome* is a particularly hazardous condition The most benign type of retention associated with partial obstruction of this segment of duodenum and jejunum is that which is reflected in periodic vomiting of large amounts of bile-stained watery fluid Such episodes may be followed by relief from the epigastric distress, and a previously present epigastric distention or discrete mass may be found to have disappeared

Much more sinister, however, are the pathophysiologic changes which occur when the obstruction of the proximal stoma becomes complete or nearly so The bile and pancreatic juice continue to distend the loop until either the duodenal stump blows out or the bowel wall becomes ischemic and, presently, gangrenous

It is highly important to diagnose proximal loop obstruction and to manage it by operation if it is not relieved spontaneously or by passage of a nasogastric tube through the proximal stoma

Blow-out of the duodenal stump (FIG 35) or *leakage at the gastrojejunal anastomosis* must be drained surgically If this is done promptly, most patients will survive Of the two lesions, the duodenal fistula is the easier one to manage Since it represents an "end" fistula, the patient can be supported with oral feedings as soon as *the drainage tract from the duodenal stump to the exterior* has been walled off In contrast the gastric defect represents a "side" fistula Here the patient must not be fed by mouth unless it can be done through a long tube passed through the nose and into the jejunum through the distal stoma Yet, such a tube can be passed in many patients if the physician tries long enough, and it may be life saving Intravenous fluids, an intake-output record, and protection of the skin of the abdominal wall by continuous catheter suction and zinc oxide or aluminum paste are all important components of supportive management In our experience, the volume of fluid delivered from the fistula to the abdominal wall diminishes markedly over the course of the next few days, and the drainage

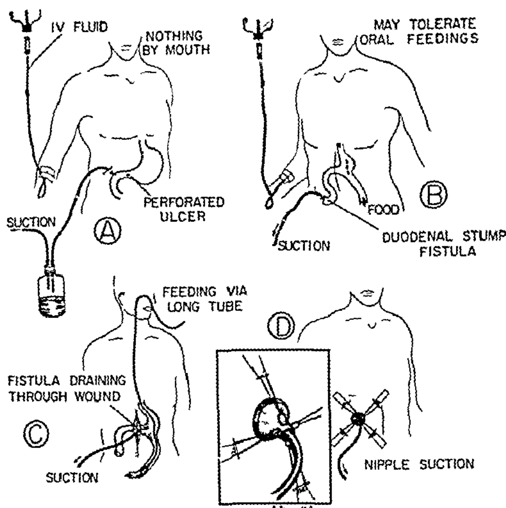


FIG 35—*Duodenal and Gastric Fistulas* (A) It occasionally happens that the surgical closure of a perforated ulcer breaks down Or a duodenotomy perhaps for common duct pathology leaks and a side fistula (gastroduodenal continuity present) develops These patients should not be fed by mouth Levin tube suction may or may not be of demonstrable value Some surgeons have advocated gastric resection to convert the side fistula to an end fistula This is a bold step but probably a justifiable one under some circumstances (B) A stump or end fistula if well drained is far preferable to a side fistula for this patient can be fed by mouth Most of these patients recover if sepsis has been avoided by prompt and adequate surgical drainage (C) Occasionally a fistula will develop at the gastrojejunal anastomosis By persistent effort a long tube can at times be passed into the distal loop and the patient thus fed This is preferable to a feeding jejunostomy performed in the presence of intraperitoneal contamination in our experience (D) Where there is no fistulous tract into which the catheter for suction can be advanced a nipple can be applied over the opening on the abdominal wall

Again the basic features of fistula management are adequate abdominal drainage and nutritional maintenance with antibiotics as indicated

may have ceased entirely by the end of from two to three weeks *Vigorous support will save many a patient with a duodenal fistula*

The *diagnosis* of the presence of a duodenal or gastric fistula can often be established prior to the drainage operation in one of several ways First, swallowed radiopaque material may be seen to outline the fistulous tract and perhaps a surrounding abscess Second, if *there is already a drainage tract, whether planned or through the* abdominal wound, orally administered methylene blue or indigo carmine may appear in the drainage fluid Third, radiopaque material injected into the drainage tract through a catheter may enter the duodenum or the stomach

Nutritional problems are best exemplified by the dumping syndrome, diarrhea or an intractable inability to maintain a reasonably satisfactory level of body weight

The dumping syndrome, most workers now believe, is caused by the rapid passage of concentrated solutions of food materials into the small bowel Normally, food is retained in the stomach until the chyme is almost isotonic with body fluids and then released in small amounts into the duodenum by the pyloric sphincter The abrupt passage of hypertonic solutions into the jejunum results in the movement of water into the bowel from the extracellular space, and the plasma volume declines rapidly and substantially This gives rise to the characteristic symptoms of abdominal cramps, weakness and tachycardia

The management of the dumping syndrome consists largely of three measures First the patient should be assured that the symptoms diminish with time in most subjects Second, relatively little fluid should be taken with the frequent (6 times daily) small meals Third concentrated carbohydrate meals should be avoided, while fats may be increased Fourth a brief period in the supine position following the meal may prove beneficial

Severe weight loss is best managed prophylactically through the proper *selection of patients for radical gastrectomy Fat subjects* or even those of average obesity may not present a severe decline in weight postoperatively, but the very lean are likely to do so Therefore, for the lean person the vagotomy-gastroenterostomy (or vagotomy-pyloroplasty) procedure may be preferable to gastric resection If the Billroth II operation was done and weight loss is excessive a second operation with conversion of the resection to

a Billroth I anastomosis may result in nutritional improvement in selected patients or vagotomy with antrumectomy may be elected

Of course, meticulous attention to enhancement of the diet that the patient does eat is also important

Abscess formation whether subphrenic or elsewhere is frequently but not always due to leakage at the anastomosis or the duodenal stump This can be a peculiarly difficult condition to diagnose especially if the patient can take food by mouth and the sepsis is somewhat suppressed by antibiotics Under these circumstances the drainage operation may be inordinately delayed To be sure, some abscesses clear up without operative intervention but too many do not in these failure to drain may result in death

Gastro-jejuno-colic fistula is a rare complication The modern tendency is to prepare the patient as well as possible and then to excise the fistula and restore bowel continuity at one operation

SMALL BOWEL SURGERY

Intestinal Obstruction

The most common condition of the small bowel for which surgery is required is intestinal obstruction Tumors of the small bowel are relatively rare in contrast to the colon where carcinoma constitutes the usual cause of obstruction In the small bowel this condition is most often produced by hernia or by inflammatory congenital, traumatic and cicatrizing lesions

In essence postoperative adhesions and hernias cause approximately 65 per cent of all cases of small bowel obstruction (TABLE 16)

TABLE 16—*Causes of Intestinal Obstruction**

1	Congenital Anomalies	5 3%
2	Early adhesions	5 5%
3	Extraluminal inflammations	3 1%
4	Intussusception	3 2%
5	*Late Adhesions*	*32 3%*
6	Diverticulitis	3 1%
7	Neoplasm	5 9%
8	*Strangulated External Hernia*	*31 8%*
9	Volvulus	4 4%
10	Adhesions Without Operation	5 1%
11	Miscellaneous	0 57%

* From Bramlitt E E Hardy J D and Wilson H Intestinal obstruction II Analysis of 1287 admissions over a ten year period Am Surgeon *21* 1091 1955

may have ceased entirely by the end of from two to three weeks Vigorous support will save many a patient with a duodenal fistula

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regional enteritis, for the liquid small bowel contents will rarely allow the barium to impact above the obstruction In contrast, to force barium past a constricting lesion in the colon at the time of barium enema is to invite acute and complete colon obstruction due to impaction of barium above the lesion Even in the absence of a colon lesion, barium given for routine G I series can impact in the colon and even cause obstruction and perforation The necrosis may be adjacent to the rock-like masses of barium or in a cecum distended because of obstruction in the distal colon

Management of Obstruction Having reached a diagnosis of mechanical small bowel obstruction, how is the condition to be managed?

It may be managed conservatively or by surgery Unless the obstruction is low and apparently complete, a period of conservative management is usually employed initially This permits time for fluid and blood infusions and for emptying the stomach and the upper reaches of the intestinal tract of fluid This period of tube suction further facilitates anesthetic management, for it renders vomiting and pulmonary aspiration less likely Conservative management may be continued indefinitely, of course, if there is a reasonable chance that surgery can be avoided, as in the instance of early postoperative adhesions and provided that the patient's general condition is improving or at least is not deteriorating Obstruction due to adhesions in the early stages of convalescence can be successfully managed by intestinal suction and intravenous fluids in fully 80 per cent of cases, and late obstruction due to adhesions can be so managed in many patients

Nevertheless, let us assume that operation is indicated What measures should be instituted? These include

(1) *Draw blood samples* for crossmatching for plasma levels of chlorides and CO and if readily available sodium and potassium The N P N level is helpful but not essential

(2) *Pass long tube* (Miller Abbott Cantor Harris) and begin continuous suction While a Levin tube is more efficient in the stomach it is hoped that the long tube (FIG 36) will pass down the bowel and serve as a splint during the early postoperative period It can later be detached at the nose and pulled through per anus If the tip of the tube is still in the stomach at the time of operation the operator can advance it into the jejunum by reefing the duodenum on the tip as one might reinsert a pajama cord attached to a safety pin

(3) *Start intravenous fluids* If vomiting has previously occurred this volume of loss must be considered in addition to the fluid that is still sequestered

Diagnosis of Intestinal Obstruction Inasmuch as small bowel surgery is most often required for the management of obstruction (gastroenterostomy not here considered) the usual diagnostic problem is that of deciding whether or not small bowel obstruction is present and, if so, what measures, conservative or operative, are required

The principal signs and symptoms of small bowel obstruction are intermittent colicky pain, perhaps abdominal distention, failure to pass gas vomiting, borborygmi, abdominal tenderness and at times a tender abdominal mass, any or all may be present The history may reveal previous abdominal operations, a previously easily reducible hernia, chronic enteritis, possible appendiceal abscess, pancreatitis that may have produced jejunal obstruction, or other findings In colon obstruction there may have been a change in bowel habits, blood in the stool and perhaps a painful mass with or without anemia The significance of high-pitched or tinkling peristalsis, associated with the intermittent cramping abdominal pain, is great In addition, most patients with mechanical bowel obstruction know surprisingly well the time when they last passed gas *Aspiration of fluid from the peritoneal cavity may be revealing*

Roentgenograms are required to supplement the findings on physical examination The plain film of the abdomen taken with the patient supine will reveal the amount and distribution of intestinal gas With the patient erect, air-fluid levels may be seen Thickening between the gas-filled loops may be due to serous effusion or to exudate The most distal point at which gas is noted often affords some indication of the probable point of obstruction, this is important for the placing of the surgical incision will be influenced by such information The roentgen appearance alone does not conclusively differentiate mechanical obstruction from paralytic ileus, though one can often predict the correct findings With the roentgen evidence and the clinical findings of cramping abdominal pain high-pitched peristaltic rushes, abdominal distention failure to pass gas and vomiting (alone or in combination), one can correctly diagnose mechanical (organic) obstruction in a large majority of cases

Occasionally it will be advisable to give barium by mouth to prove partial or complete small bowel obstruction, especially if the point of obstruction lies high in the jejunum This use of barium is a safe one, even if the bowel is merely stenotic as in chronic

These four measures are the basic ones in beginning the management of serious intestinal obstruction Needless to say, there are many degrees and types of intestinal obstructions, many of which are dealt with without surgery Our therapy here, then, is directed toward preparing the patient for operative correction of a lesion that is not likely to subside spontaneously or which threatens strangulation of the bowel and gangrene For this reason antibiotics are administered (penicillin, streptomycin) to minimize intraperitoneal sepsis in case there is a leakage of fluid through the bowel wall prior to surgery

Colon obstruction (representing a closed loop) is treated by surgical means

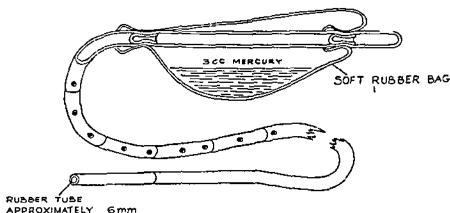
Cause of Death in Intestinal Obstruction (FIG 37) The treatment of various pathologic conditions can often be conducted more intelligently if the more likely fatal complications are known This is especially true of intestinal obstruction For example, simple obstruction of the upper jejunum, where no closed loop exists, can be managed conservatively for an indefinitely prolonged period of time The major hazard here is that of shock due to water and salt loss, and as long as these losses are replaced parenterally, the general condition of the patient does not rapidly deteriorate To be sure, gradual starvation will occur, but the decompression of the upper jejunum by vomiting or tube suction will prevent overdistention with consequent ischemic necrosis of the bowel wall In low ileal obstruction, on the other hand, and, above all, in colon obstruction, the greater hazard is necrosis of the bowel wall with peritonitis, rather than fluid loss This is not to say that fluid loss into the bowel lumen and through vomiting does not occur, but here the loss is not as great as in high obstruction At the same time, the fluid and gas that distend the ileum are much less readily removed by vomiting than in the case of jejunal obstruction Hence, constant distention of the bowel may gradually occlude the smaller vessels that supply the bowel wall and "pressure necrosis" leads first to leakage of bowel contents through the damaged wall and ultimately, actual perforation

Therefore, in most instances low ileal and colon obstruction must be relieved by surgery Indeed since colon obstruction represents a closed loop between perhaps a sigmoid carcinoma and a competent ileocecal valve in more than half of such cases, as noted

in the gastrointestinal tract Several liters may be aspirated in two hours of preparation prior to surgery Thus since salt containing fluid has been lost it is practicable to begin 1 000 cc of isotonic saline in 5 per cent glucose solution while the plasma electrolyte levels are being determined Fluid therapy is discussed elsewhere (p 12), but one can readily give 500 cc of blood and from 2 to 3 liters of noncolloid fluid over the course of three hours of preparation for surgery

(4) *Give antibiotics*

A



B

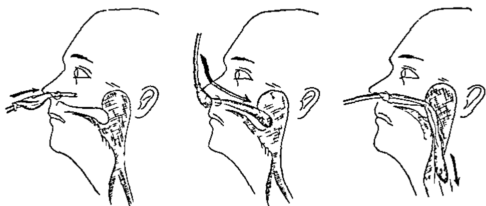


FIG 36—A long tube is especially valuable in the management of ileus post operative distention and partial mechanical obstruction It is very helpful in patients who have an *abdominal aneurysm resected The tube should of course be* passed prior to surgery when its need can be anticipated however with perseverance it can be passed into the small bowel after operation in many patients (After Partipilo A V Surgical Technique and Principles of Operative Surgery Philadelphia Lea & Febiger 1957)

These four measures are the basic ones in beginning the management of serious intestinal obstruction Needless to say, there are many degrees and types of intestinal obstructions, many of which are dealt with without surgery Our therapy here, then, is directed toward preparing the patient for operative correction of a lesion that is not likely to subside spontaneously or which threatens strangulation of the bowel and gangrene For this reason antibiotics are administered (penicillin, streptomycin) to minimize intraperitoneal sepsis in case there is a leakage of fluid through the bowel wall prior to surgery

Colon obstruction (representing a closed loop) is treated by surgical means

Cause of Death in Intestinal Obstruction (FIG 37) The treatment of various pathologic conditions can often be conducted more intelligently if the more likely fatal complications are known This is especially true of intestinal obstruction For example, simple obstruction of the upper jejunum, where no closed loop exists, can be managed conservatively for an indefinitely prolonged period of time The major hazard here is that of shock due to water and salt loss, and as long as these losses are replaced parenterally, the general condition of the patient does not rapidly deteriorate To be sure, gradual starvation will occur, but the decompression of the upper jejunum by vomiting or tube suction will prevent overdistention with consequent ischemic necrosis of the bowel wall In low ileal obstruction, on the other hand, and, above all, in colon obstruction, the greater hazard is necrosis of the bowel wall with peritonitis, rather than fluid loss This is not to say that fluid loss into the bowel lumen and through vomiting does not occur, but here the loss is not as great as in high obstruction At the same time, the fluid and gas that distend the ileum are much less readily removed by vomiting than in the case of jejunal obstruction Hence, constant distention of the bowel may gradually occlude the smaller vessels that supply the bowel wall and "pressure necrosis" leads first to leakage of bowel contents through the damaged wall and, ultimately, actual perforation

Therefore, in most instances low ileal and colon obstruction must be relieved by surgery Indeed since colon obstruction represents a closed loop between perhaps a sigmoid carcinoma and a competent ileocecal valve in more than half of such cases, as noted

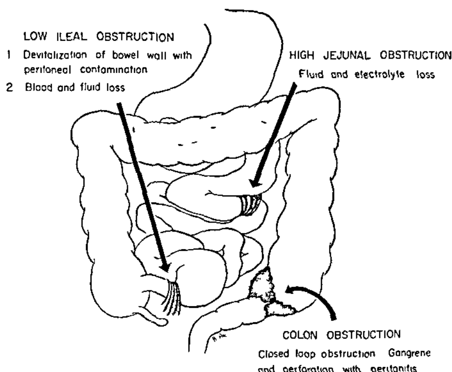


FIG 37—*Pathophysiology of Bowel Obstruction at Various Levels* There is a wide spread impression that high small bowel obstruction is 'worse' than low small bowel or colon obstruction It is true that high obstruction is accompanied by greater water and salt loss through vomiting but assuming that these losses are replaced conservative management can be continued for many days without serious risk of the development of strangulation and gangrene In contrast to manage complete low small bowel obstruction conservatively is always to run the risk of devitalization of the bowel wall with peritoneal contamination and complete colon obstruction should virtually never be managed conservatively Colon perforation is associated with a very high mortality rate Although relatively little vomiting may be observed patients with low small bowel obstruction may lose large amounts of extracellular fluid plasma protein and blood into the bowel lumen This fluid is not physiologically available to replace blood volume and should be compensated for by intravenous therapy

above, conservative management with tube suction is a hazardous choice of therapy, surgery for the purpose of decompressing the distended colon is mandatory Perforation of the obstructed colon often has highly lethal consequences because of the vicious character of the bacterial flora contained therein

At surgery, we feel it is valuable to irrigate the peritoneal cavity with copious quantities of saline solution if strangulation obstruction is present, in addition to continued and massive antibiotic therapy A combination of penicillin and streptomycin has proved valuable

Complications of Gastrointestinal Tubes (FIG 38) The use of alimentary tubes is not without certain risks Most prominent among these are (1) ulceration and even perforation of the esophagus, (2) perforation of the bowel proximal to a point of obstruction if the metal tip of the tube is allowed to press too long against the bowel wall at one point, (3) intussusception, (4) difficulty in removing the tube, perhaps due to a knot in it, (5) gastric retention in the presence of a long tube far down in the bowel and (6) excoriation or even necrosis due to improper fixation of the upper end of the tube (FIG 38) Fortunately, these and other complications are rare on a percentage basis, but one should be alert to the possibility that they may occur

Postoperative Management During the postoperative period the preoperative measures are continued Gastrointestinal suction, fluid replacement, blood transfusion and antibiotics are employed as in-

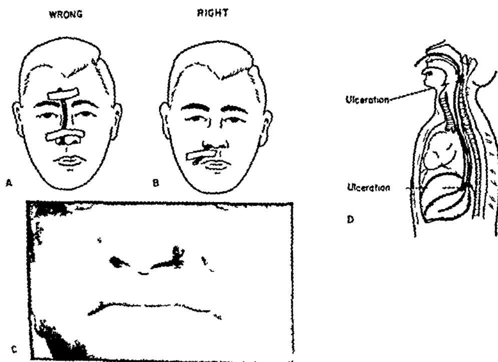


FIG 38—The *nasogastric tube* (Levin of New Orleans) is a most valuable adjunct in abdominal surgery It will probably survive the current advocacy by some of gastrostomy for postoperative decompression Complications which are few include ulceration at pressure points—as at the nose when tube is kinked upward (A and C) in the posterior pharynx and at the cardia (D) A loop or knot may occur in the tube and nasopharyngitis and pulmonary aspiration may be somewhat more prone to occur when a tube is used especially in infants

dicated If the obstruction has been satisfactorily relieved by surgery, as it usually is, convalescence that soon permits oral intake should proceed rapidly, except where bowel was resected for gangrene The operative mortality in simple small bowel obstruction is now less than 10 per cent, whereas that for strangulation obstruction with gangrene is perhaps 25 per cent

Other Diseases of the Small Bowel That May Require Surgery

In addition to frankly obstructing lesions, inflammatory lesions of the small bowel such as regional enteritis and Meckel's diverticulitis must be considered The latter is usually discovered in a search for the source of gastrointestinal hemorrhage, or at laparotomy for supposed acute appendicitis Regional enteritis, however, can be a *most distressing problem, not only from the standpoint* of preoperative and postoperative care, but from the standpoint of long-term treatment Malnutrition, infection, perforation, enteric fistulas, bleeding, obstruction and debilitating fever and diarrhea are all possible complications of this disease whose etiology remains obscure To resect all the bowel that may be successively involved over a period of years may be to risk small bowel insufficiency for food assimilation Therefore, the wisest course is one in which the surgeon operates only when complications force *him to do so* Supportive therapy should include a low-residue high-caloric diet that the patient will eat and which does not increase the diarrhea, conservative management of obstruction with a tube when possible, antibiotics for intraperitoneal infection due to minor bowel leaks, blood transfusions, and perhaps corticosteroid therapy in the occasional case

The patient may be virtually an invalid for many years, but the hope may be cherished that eventually the condition *will burn* itself out

Despite the desire to avoid small bowel resection where possible in some subjects the complications listed above may force excisional surgery Small bowel insufficiency is related less to the length of bowel excised than to that remaining *in situ*, the length of the normal small bowel varies considerably from one individual to another and such variations may be even more exaggerated in the presence of intestinal disease *With* constant dietary *attention and* meticulous care, many patients can maintain a reasonably satis-

factory state of nutrition with only 5 feet of jejunum remaining However, this represents the practical minimum in most instances Half the small bowel can readily be sacrificed in most subjects without the production of major nutritional problems

LARGE BOWEL SURGERY

In general more specific preparation is employed for colon resection than for small bowel resection The reasons for this are several First small bowel resection is most often performed as an emergency procedure, without prior knowledge that resection would be required, it was known only that the patient had intestinal obstruction and that oral intake was contraindicated Second, the bacterial flora in the stomach is not as vicious as in the small bowel, and not as pathogenic in the small bowel as in the colon Thus, the use of antibiotics for reduction of the bacterial flora prior to small bowel resection, when feasible, is not as important as it is prior to colon resection Third, the liquid contents of the small bowel can be readily displaced before gently occluding clamps are applied to prevent spillage with peritoneal soiling during anastomosis Firm feces in the colon cannot be so readily removed from the site selected for anastomosis and peritoneal contamination is more likely to occur Fourth a colon full of firm feces renders exposure and general maneuverability more difficult Fifth, a full bladder does not seriously interfere with small bowel resection, but it does retard exposure of the colon in the pelvis A catheter should be inserted preoperatively when low colon surgery is contemplated

So, whereas attention to the correction of water, electrolyte, and blood deficits is particularly important in lesions of the small bowel (where surgery is most often required for the relief of obstruction), cleansing of the commonly nonobstructed colon of feces and bacteria is a most important objective prior to surgery upon it

Diagnosis of Colon Disease

The *history* and *physical* examination usually reflect evidence of the disease which prompted the patient to seek medical advice Of course if acute obstruction has developed perhaps the result of ultimate complete occlusion in a patient who has long had partial occlusion from a constricting carcinoma the symptoms and signs are as previously outlined for intestinal obstruction The principal

ones are, again, abdominal pain that is usually cramping in nature, distention and failure to pass gas Nausea is often present but vomiting may be a late symptom in colon obstruction On auscultation high-pitched borborygmi may be heard, until the activity of the bowel is beginning to fail prior to paralysis due to exhaustion and perhaps impending gangrene Prolonged intermittent pain, followed by a silent abdomen with no evidence of relief of distention plus abnormal vital signs, is an ominous state of affairs, for bowel necrosis may have occurred

The data obtained from the history and physical examination will lead to the taking of a plain (flat) film of the abdomen, and the most distal point which the gas has reached in the distended colon often indicates the site of obstruction However, this is not always clearcut and a gently performed barium enema (FIG 39) may delineate the level of obstruction and thus permit a more accurately placed decompressing colostomy

Nevertheless, many colon lesions are diagnosed and operated on before obstruction has occurred Moreover, even if a decompressing colostomy does have to be performed proximal to an obstructing lesion there still remains the need for careful preparation before resecting the cause of obstruction (usually representing *tumor* volvulus, or inflammatory disease in the colon, rather than adhesions or hernia as in obstruction of the small bowel)

Nonobstructing colon lesions usually are investigated because they have produced rectal bleeding, abdominal pain, a mass, or a change in bowel habits in the form of diarrhea and constipation that often alternate The usual course of study of the colon is

(1) History and physical examination
(2) Rectal examination (supposedly a part of every physical examination but so often omitted that it is listed separately)
(3) Proctosigmoidoscopic examination for visualization collection of feces for laboratory study (blood parasites ova) and *biopsy* (tumor amoebae etc)
(4) Barium enema (routine and air contrast study when indicated)

Needless to say colon pathology may simulate gastric or other pathology, and vice versa

Preoperative Preparation

Let us assume that a constricting lesion of the upper rectum or low sigmoid exists presumably representing carcinoma Perhaps biopsy proof exists No other lesions are disclosed by barium enema



Fig 39—*Typical Constricting Lesion of the Sigmoid Colon* Note small bowel loops The ileocecal valve is incompetent in about 50 per cent of cases Whereas incomplete small bowel obstruction is rarely rendered complete by a barium meal to force barium past a constricting colon lesion at barium enema is to invite impaction of the medium above the lesion with resulting complete obstruction This may require a preliminary colostomy for decompression which must later be closed rendering three operations necessary where a single primary resection and anastomosis of an unobstructed colon segment might have sufficed

The following measures will usually be carried out, in order, prior to surgery

(1) Routine laboratory work that includes N P N and ECG Transfuse if hemoglobin and hematocrit levels are below normal
(2) Oral medication for reducing intestinal bacterial flora This may be streptomycin (0 5 Gm q i d for 3 days) neomycin (0 5 Gm b i d for three days), or sulfasuxidine (3 0 Gm t i d for one week)
(3) Low residue diet
(4) Gentle saline laxative every second day in most patients

(5) Enemas until returns are clear on the evening before surgery. If an enema is employed the morning of operation time should be allowed for thorough evacuation of the colon before surgery.

(6) Passage of a long tube well down into the small bowel 24 hours prior to surgery. Where a colostomy is anticipated a simple Levin tube is used—and it will suffice in most patients who have a primary resection. Certainly the long tube in the small bowel will not aspirate gas and fluid that do not reflux through the ileocecal valve. However we feel that small bowel decompression is best achieved by means of the long tube; swallowed air is aspirated. There is, however, a general tendency to use all alimentary tubes less frequently and to substitute the short nasogastric tube for the long intestinal tube.

(7) An indwelling Foley catheter is inserted before the patient is moved to the operating room if the lesion is below the upper sigmoid level.

These, then, are the special measures usually employed in the preparation of the colon for surgery. On occasion other items are important, such as an intravenous pyelogram to detect ureteral obstruction or the passage of ureteral catheters to aid in identifying ureters in a patient where pelvic dissection may be unusually difficult.

Of course, the preparation of the patient (rather than the colon) for colon resection includes the general measures described in the first three chapters. As for improving nutrition, however, while certain requirements such as vitamins can be readily supplied, one need not expect materially to improve the basic nutrition of the patient with carcinoma of the colon until the lesion has been removed. Adequate preoperative, operative and postoperative blood transfusion is important.

The Operation: Colon Resection

Smoothness of convalescence is often rendered either probable or unlikely by the technical quality of the operation. Taking the *abdominoperineal resection* as an example, fecal spillage is to be minimized regardless of how much oral antibiotic therapy the patient has received preoperatively. Hemostasis should be carefully achieved. Ureteral or bladder injury should be avoided. Convalescence can be inordinately prolonged by the drainage of urine through the perineal wound. Bladder defects may close spontaneously, but a ureteral fistula may eventuate in nephrectomy unless the ureter can be reimplanted into the bladder at a level above the defect. Repair of the pelvic floor (reperitonealization) should be done so as to prevent prolapse of small bowel. Incidentally, when bowel does prolapse it can at times be replaced from below using

sponge forceps, the defect in the peritoneum is then occluded with vaseline gauze or rubber dam, against which additional packing is placed for support If the proximal colon employed for the colostomy is to be sutured to the left lateral wall intraperitoneally, these sutures should be placed at close intervals so as not to permit the prolapse of small bowel between them to cause obstruction postoperatively An adequate length of proximal colon should be mobilized so that when the proximal stoma is drawn through the anterior abdominal wall as a colostomy this segment of bowel is not under tension If it is under tension it may retract to a point flush with the skin or into the depths of the body wall, or, the tension may result in *ischemic necrosis (gangrene) The colostomy* should initially extend freely to approximately 1 to 1½ inches above the skin of the abdominal wall, exclusive of the portion crushed by the occluding clamp which will slough anyway This allows for the shortening of the colostomy by cicatrix as it "matures" over the next few weeks, leaving eventually a length of from ¾ to 1 inch above the skin This length facilitates the irrigation and other care of the colostomy

It is wise to make certain that the fascia of the external oblique muscle is adequately opened so that the colostomy will not be compressed at this point, and the excision of a small elipse of skin surrounding the stoma will delay the development of the stricture that so commonly occurs Other complications of colostomy are prolapse and hernia formation

Primary Anastomosis, Special Features In the instance of segmental colon resection with primary anastomosis, one needs principally to prevent peritoneal contamination, to make certain that the ends of the bowel to be anastomosed have a good blood supply (do they bleed when debrided?), that a precise serosa-to-serosa approximation is provided without the inversion of excessive amounts of tissue, and that the defect in the mesentery is closed Incidentally no matter how careful one is to avoid the inversion of too much tissue during the anastomosis, a barium enema performed several months later will often disclose a disconcertingly small lumen due to scar contracture at the anastomosis This is especially marked if a proximal colostomy has kept the lower colon defunctionalized However, these anastomoses rarely produce late obstruction

An anastomosis may, nevertheless, become obstructed because of an inordinate amount of edema such as one can occasionally observe in the loops of a transverse colostomy When this occurs it may precipitate acute closed loop colon obstruction in the presence of a competent ileocecal valve, especially if fluid and gas have advanced down the bowel after removal of the long tube and early feeding This obstruction can be managed by a cecostomy, performed under local anesthesia, if advisable In a few days the anastomotic edema subsides, the obstruction is relieved and the cecostomy tube may be withdrawn to permit spontaneous closure of the cecostomy fistula In fact, a cecostomy tube should not be removed until there is no longer a need for the decompressing vent, for otherwise the rapid closure of the tract (even in 24 to 48 hours) may require another operation to reinsert the cecostomy tube

Postoperative Management

If the patient has been adequately prepared for surgery and has good supportive therapy, anesthesia and technical surgery during operation the *colon resection with primary anastomosis* presents few problems The anal sphincter is dilated to protect the anastomosis If a catheter was inserted it is removed within 24 hours Continuous suction is used with the long tube until the patient has passed gas postoperatively, since this usually demonstrates permanent patency of the colon anastomosis, the tube is withdrawn in stages to avoid intussusception due to excessive "reefing" of the small bowel We have recently encountered several cases of small bowel intussusception following the use of long tubes Oral intake of liquids is resumed as soon as the long tube is removed, usually on the third postoperative day but often before Actually, *it is comforting to have the tube still in place if early feeding produces* abdominal cramps and distention Meanwhile, fluid intake has of course been maintained intravenously Antibiotics are continued until the fifth P O D Skin sutures are removed on from the fifth to the seventh P O D and retention sutures on the eighth or ninth day following which the patient is discharged if all is well

In the case of *abdominoperineal resection* postoperative care entails the use of certain additional measures, chiefly in connection with the colostomy and the perineal wound The end clamp on the sigmoid colon forming the colostomy was elevated, without tension, by encircling the colon extending from the skin to the clamp with

plain gauze dressings at the close of the operation, the stump or stoma occluded with the clamp being covered with vaseline gauze. The dry gauze adheres to the colon and tends to prevent retraction, and will be removed at the end of perhaps 7 or 8 days when the colon is firmly adherent to the abdominal wall through which it has been exteriorized. On about the third postoperative day, despite continuous suction on the Levin tube which presumably has prevented the passage of any considerable amount of gas (largely swallowed air) into the bowel, the patient will begin to have cramps due to occlusion of the colostomy by the clamp. At this time the colostomy is opened. We formerly sutured a large catheter into the colon just proximal to the clamp, to minimize contamination of the abdominal wall for several days longer, but in the past year or so we have simply removed the occluding clamp except in special circumstances. The gauze surrounding the colostomy is not removed for several more days, though, being simply covered with vaseline gauze, leaving only the stoma uncovered. If gas is not noted to escape when the clamp is removed, especially if cramping pains have been present, one must make certain that the colostomy is surely patent. This may require careful passage of a rectal tube into the colostomy. The Levin tube is then removed, since peristalsis has manifested itself and obstruction is no longer present. Two days later, irrigation of the colostomy with whatever volume of water proves suitable is begun first by the nurses and then carried on by the patient *before he leaves the hospital*. He must be encouraged by the assurance that within six months the management of his colostomy will be a matter of little concern. Following discharge he should introduce a finger (preferably gloved) into the colostomy at least weekly, and should report back to follow-up clinic if stricture formation begins. The surgeon can then decide himself whether finger dilatation or sharp excision of the skin stricture under local anesthesia is the treatment of choice. Forceful dilatation, one that produces cyanosis of the stoma and bleeding, is to be avoided, for it may produce a tear in the bowel wall below the skin, with fistula formation.

The *perineal wound* occasions surprisingly little difficulty in most patients. It may be closed around Penrose drains or it may be left widely open and packed. We usually leave it largely open and introduce a length of "spleen roll" gauze packing inside of a sheet of cellophane that will not adhere. Of course, the cellophane has no

hemostatic activity and all bleeding points should have been ligated before the sheet of cellophane against which the packing is introduced was inserted In this connection the depths of the perineal wound can be well visualized if the walls are retracted with 3 Deaver retractors and a spotlight directed into the depths of the incision

A portion of the packing is removed on from the third to the fifth postoperative day and the remainder the next day, after which sitz baths are begun Since the perineal defect is widely open to the exterior for free drainage, the lack of absolute sterility of the bath water is largely immaterial In fact, the perineal wound is notoriously difficult to infect even when there is gross fecal contamination due to a tear in the colon in the course of the perineal dissection The baths are continued twice a day until the perineal wound has become almost entirely filled with granulation tissue

Ureteral and bladder injuries are more common than the published reports might suggest As stated previously, a bladder that is draining into the perineal wound will usually close in a few weeks An undetected ureteral injury may require operation for peritonitis or may seal off by stricture formation and produce hydronephrosis or may drain through the perineal wound until the patient demands that something be done Since most methods of ureteral anastomosis are futile except when the proximal end of the severed ureter can be made to reach to the bladder or to a tube constructed of the wall of the bladder, some surgeons simply make certain that the opposite kidney is functioning and then remove the kidney on the side of the ureteral injury Actually, probably in many instances a ureter is ligated at surgery and the error is never known even by the surgeon More recently it has been suggested that the kidney be moved to the pelvis and the renal artery sutured to the iliac artery and the renal vein to the iliac vein, affording adequate length of ureter for ureterovesical anastomosis

Postoperative bladder dysfunction can be quite a bothersome problem for marked urinary retention may occur when the catheter is removed If the residual urine volume is greater than 200 cc after the patient has voided the catheter should be left in place for several days, then removed and the volume of residual urine again checked It is better to evaluate bladder function by removing the catheter early in the *morning than at bedtime for the bladder may*

become overdistended during the night further aggravating the atonic or hypotonic state A part of the dysfunction may be due to inflammatory fixation and loss of support of the posterior bladder wall, but excision of sympathetic nerves may also be important In any event, with patience catheter drainage and perhaps the use of urecholine, bladder function gradually improves in these patients and the catheter can eventually be removed permanently In the occasional patient, prostatic surgery will be required

Ileostomy and Ileoproctostomy

Ileostomy A permanent ileostomy may be performed for the management of chronic ulcerative colitis, at or prior to colectomy, or following colectomy for multiple familial polyposis

It is not in order to discuss here the various types of ileostomy that have been devised to reduce the postoperative incidence of the complications that develop in fully a third of such patients regardless of technic Naturally the stoma must have been so placed as to permit the precise and comfortable application of an ileostomy bag In general, the stoma must be situated at not less than 1½ inches from the anterior superior spine of the ilium It must not be too close to the umbilicus or to depressed abdominal scars, for then the doughnut-shaped rim of the appliance will not lie flat against the skin and ileal contents will leak regardless of the type of cement that is used between the appliance and the skin Nevertheless, ileostomy bags have been successively improved until now most patients can avoid leakage

When movements through the ileostomy stoma begin a day or so following surgery, the copious liquid material may produce severe excoriation of the surrounding skin if a protective paste or ointment is not applied Zinc oxide ointment may suffice, aluminum paste is reasonably effective but its color soils the patient's gown, hands and the bedclothes Most hospitals have one or another of these various pastes and powders in stock in the pharmacy or on the dressing cart They must be reapplied frequently Until the patient can wear the ileostomy appliance, catheter suction or some other device is used to direct the ileal contents into a receptacle Rubber dam material can be sealed around the edges and the folds led to a basin beside the patient A heating lamp (even of the goose neck type) will assist in maintaining a dry skin

In a matter of days, weeks or months, however, the thickness of the ileal flow increases and excoriation of unprotected skin is less noticeable The patient must himself learn all the details and intricacies of the management of his own ileostomy Especially will he discover by trial and error the foods which produce "diarrhea"

Fluid and *electrolyte* losses may be large (4 to 5 L daily) during the first few days following the ileostomy During this period careful attention must be given to adequate replacement of these losses This is, of course, facilitated by gentle catheter suction within the stoma, along with collection and measurement of overflow The volume of loss should be estimated, for otherwise one must depend entirely on the physical signs of hydration or dehydration and the plasma chemistry values as guides to fluid replacement As stated, the ileal fluid losses tend to diminish with time, but even years later an explosive diarrhea in the patient with an ileostomy may require hospitalization for intravenous fluid therapy

The most common later complications of ileostomy, after the immediate postoperative period, are fistula and abscess formation, obstruction stricture prolapse and herniation While the complications of ileostomy are not unlike many of those which follow colostomy, the incidence and the difficulties encountered in correction are much less with colostomies than with ileostomies Moreover, the patient has far less frustration in managing a colostomy than an ileostomy The fecal flow of a sigmoid colostomy is almost solid and most patients do not require a colostomy bag they irrigate the colostomy once a day and after it is emptied no further movement of consequence occurs until it is irrigated again the next day Not so with the ileostomy however, for here a bag must be worn, and the odor can not often be completely removed from the prosthesis Thus the patient with a colostomy usually has to worry about the cancer that was resected whereas the patient with an ileostomy does not usually have to worry about a cancer but worries about a life with an ileostomy The patient with either requires considerable moral support and attention

Ileoproctostomy In recent years multiple polyps of the colon and, in particular, multiple familial polyposis have been managed in many instances by resecting the colon to the level of the pelvic floor or below, and then anastomosing the ileum to the rectum

Any further polyps that develop in the rectum are visualized through the proctoscope and cauterized at regular follow-up visits We have found this a very satisfactory procedure in the limited number of patients in whom it has been employed During the first few weeks liquid bowel movements are many and perianal excoriation may be intense, requiring protection from ileal contents as outlined above As the weeks and months pass, however, the number of bowel movements per day declines the material becomes more firm in consistency and the perineal excoriation is no longer a problem, even without the use of protective ointment Furthermore, the patient is far more satisfied with his lot than if he had an ileostomy, and it is a simple matter to snare or fulgurate new polyps in the rectum through the sigmoidoscope

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(6) Expose the major internal hemorrhoidal masses (usually three in number) and resect by whatever method is desired. We frequently dissect the hemorrhoid out but at other times we simply ligate the base, apply a clamp, excise above the clamp and close the bed with a running *chromic catgut* suture beneath the clamp. The clamp-cut-oversew method is by far the most commonly used one and it is quite satisfactory in most instances.

(7) Avoid excision of too many hemorrhoids with too much mucosa. The most chronic complication of hemorrhoidectomy is an anal or low rectal *stricture*. It is far preferable to leave behind an occasional hemorrhoid than to excise all visible veins at the serious risk of a stricture.

(8) Excise the external hemorrhoid and adjacent skin tab cleanly, for otherwise edematous lumps will be palpated by *the patient postoperatively. He may* then conclude that a poor or inadequate operation was done. Here again, however, excessive excision of skin as with mucosa can result in a stricture.

(9) Secure *hemostasis* at surgery. Slow but serious venous bleeding into a capacious rectal ampulla postoperatively is one of the most common significant complications of hemorrhoidectomy.

(10) Final inspection. Is lumen adequate? Is cosmetic appearance satisfactory? Have the major hemorrhoidal masses been excised?

(11) Anesthetic ointment and a Penrose drain are inserted. Many surgeons inject a long acting local anesthetic into the sphincter and surrounding tissues to relieve painful spasm over the next several days. We have not employed these agents because of the occasional reports of infection, necrosis or slough following their use.

(12) A simple abdominal pad dressing is applied to absorb drainage.

Postoperative Care

(1) Opiates as required for pain during the first 48 hours. This period, when sphincter spasm can be severe and excruciatingly painful, is a crucial one and discomfort should be treated vigorously. Moreover, it is this pain (or the absence thereof) which the patient will remember and associate with the operation. Again, one should make certain that the patient actually gets enough opiate to provide relief.

(2) Drain is removed after 6 hours, when chances of hemorrhage have become remote.

(3) Warm sitz baths are begun on morning following surgery and continued t.i.d. during the first 5 days. The soothing effect of these baths is frequently emphasized by physician patients who have just undergone hemorrhoidectomy. A simple dressing is reapplied after each sitz bath, until drainage is so minimal as not to soil pajamas or bedclothes.

(4) Mineral oil 15 cc. b.i.d. P.O. is begun on the first postoperative day and continued until after the first bowel movement, after this the dose is reduced to 15 cc. q.d. for five additional days and then discontinued.

(5) Diet as desired post nauseam.

(6) Ambulation as desired. Few patients will walk much for a day or so.

(7) Urination is often difficult in both men and women following operations about the anus. However, all usual measures (p. 67) should be tried before catheterization is resorted to.

(8) No antibiotics are used.

(9) Dilatation only by bowel movements during first two weeks. Thereafter the little finger and later the index finger should be inserted to detect any stenosis

15 *Hemorrhoids, Anal Fissure, Fistula-in-Ano, Pilonidal Sinus and Certain Hernias*

THE PREOPERATIVE, operative and postoperative measures employed in the management of lesions about the anus are not usually extensive, but careful attention to detail is essential to good operative results and patient comfort. To the patient who is to have hemorrhoidectomy, the operation is major.

In this chapter, where physiologic considerations require less explanation than in many other sections of this volume, an outline form of presentation will be employed.

HEMORRHOIDECTOMY

Preoperative Measures

(1) Establish that hemorrhoids are present by inspection for external lesion and by digital and anoscopic examination for internal lesions
(2) Sigmoidoscopy (to rule out chance of cancer of lower colon as cause of bleeding)
(3) Barium enema to exclude other lesions
(4) Warm moist compresses and/or sitz baths for thrombosed, ulcerated or prolapsed hemorrhoids prior to formal hemorrhoidectomy
(5) Evacuate (incise under local anesthesia) acutely thrombosed external hemorrhoid to relieve pain while awaiting formal hemorrhoidectomy if required
(6) Prepare for hemorrhoidectomy by shaving the area, cleansing enemas and the usual preoperative sedation

Operative Considerations

(1) The prone jack knife position with the trunk lowered to about 30 degrees from the horizontal with the legs more sharply flexed is quite satisfactory and is well tolerated by most patients. It is preferred. In the severely dyspneic individual a lateral or Sims horizontal position can be used
(2) Tape buttocks apart with two strips of 2 inch adhesive tape on each side
(3) Anesthesia is best secured by a caudal block. In very ill patients in whom only the prolapsed hemorrhoidal masses are to be excised to improve comfort, local anesthesia is satisfactory
(4) Under anesthesia the external and internal hemorrhoids are usually far more apparent than they were when sphincter tone was present
(5) With lubricant on the gloved finger the sphincters are slowly and gently dilated until three fingers are readily admitted. To dilate too rapidly and forcibly will often result in a tear in the mucosa

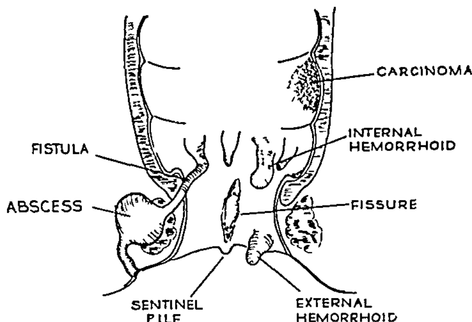


Fig 40—*Ano Rectal Lesions* The perirectal abscess begins presumably with an egress of contaminated material from the rectum usually at the base of a crypt of Morgagni The abscess thus formed may subside or it may rupture through the skin of the buttock or back into the bowel or it may be drained surgically A fistula is present when the tract extends from the lumen of the bowel through the perianal tissues to the exterior Internal hemorrhoids are often associated with a degree of prolapse and are apt to require surgery eventually The sentinel pile is not a hemorrhoid but a hypertrophied skin tab adjacent to a fissure in ano Bleeding per rectum may be due to a variety of causes Digital examination proctoscopic visualization and barium enema with contrast air study are all important steps in evaluation of the pathology that may be present Even hemorrhoids are major lesions to the patient and here the surgeon can employ much surgical art with little surgical risk—a happy circumstance

sphincter Under anesthesia these ends were exposed, sutured together with chromic catgut, and fecal continence was completely restored to a very grateful patient

Surgical management of fistula-in-ano is usually required When the external opening of the fistula is posterior to a transverse line, the internal opening will usually be found in the posterior midline When the external opening is anterior to the transverse line, the internal opening of the fistula is often situated in the radial relationship Anoscopic examination will frequently reveal the internal opening of the fistula

If an acute abscess is encountered, it is well to drain it and postpone formal excision of the fistulous tract until later Otherwise, a probe is passed through the external opening into the anal canal or lower rectum, and the tract surrounding it is excised and packed

and to prevent stricture formation Many patients will do this themselves but many others will not even when given finger cots for the purpose and the surgeon is well advised to insist that the patient return at least twice (at 3 weeks and 3 months) for digital examination

(10) Recurrence of hemorrhoids cannot be prevented absolutely but this complication is uncommon if adequate surgery is performed at the initial operation

ANAL FISSURE

This lesion is essentially a longitudinal crack in the anal mucosa which can be exceedingly painful due to associated sphincter spasm The fissure most often occurs in the midline posteriorly Conservative measures include a low residue diet, mineral oil to keep the fecal mass soft, soothing ointments and suppositories and frequent warm sitz baths However, while many fissures will heal with such measures and "tincture of time," some fissures will require more active intervention

Surgical excision is usually successful and simple to perform Under local or regional anesthesia the sphincters are dilated, and the deep fissure (tract) is excised down to sphincter muscle, along with the external skin tab (sentinel pile) so frequently present

Preoperative and postoperative measures are quite similar to those described for hemorrhoidectomy

FISTULA IN ANO

A fistula-in-ano usually follows the spontaneous or surgical drainage of a perirectal abscess That is, through a defect in the lower rectal or anal mucosa the bacteria escape into the surrounding tissues and produce an abscess which eventually obtains exit outside or lateral to the confines of various portions of the anal sphincters (FIG 40) Thus in some cases of fistula one can excise (*"ream out"*) the tract with division of only superficial sphincter fibers, but in others which pass completely behind the main external sphincter muscle mass one can divide this muscle only at considerable risk of postoperative anal incontinence We have occasionally divided a major portion of the external sphincter in excising a fistula, but we have always reapproximated the ends of the muscle with one or more chromic catgut sutures We recently (1957) examined a patient with fecal incontinence whose entire external sphincter had been boldly divided at one point during the course of excision of a fistula-in-ano On digital rectal examination one could readily identify the widely separated ends of the external

tract before making the eliptical incision with which to excise the involved skin One then keeps the dissection wide of any bluish discoloration excising involved tissue down to the presacral fascia Hemostasis and asepsis should be meticulous

It is our experience that with complete excision of diseased tissue, prevention of hematoma and infection and avoidance of undue tension on the suture line during the first two weeks postoperatively, few pilonidal wounds fail to heal *per primum* The subcutaneous tissue is closed with fine catgut sutures to obliterate dead space and the skin is closed with silk or fine wire Tape is applied transversely over the dressing so as to relieve tension on the suture line

Postoperative measures which we consider important are, first and foremost, the prone position in bed or the standing position when out of bed (no sitting) for 10 days Actually, the patient is discharged from the hospital in seven days, if the wound is clean and healing well The skin sutures should be removed only after the skin margins appear to be securely united, for if bacteria gain access to the subcutaneous tissue the wound may well become infected Second, the patient is not encouraged to have a bowel movement during the first 48 hours postoperatively, but thereafter diet and elimination are allowed to proceed ad lib Third, the dressing is changed often enough to prevent maceration of the skin The wound is always redressed in such a manner that adhesive tape pulls the buttocks together and prevents tension on the suture line

INGUINAL HERNIA

The repair of hernias of various types constitutes a considerable segment of surgical practice The inguinal hernia (FIG 41) is the most common hernia in both sexes and in all age groups, and an outline of its management will serve as a prototype of that of other types, in many respects

Preoperative Measures

(1) Establish diagnosis

(a) *Inspection* and *palpation* for a bulge in inguinal region Direct or indirect defect? (Does it protrude along the inguinal canal or not?)

(b) *Impulse* at external ring on coughing (questionable or minimal hernia but often must be repaired for patient to get a job in industry)

(c) *History* of hernia that was down but is now not discernible (common in youngsters where mother's word must often be taken)

(d) *Previous operation* for hernia or hydrocoele?

open Again, if the main mass of the external sphincter must be divided to perform adequate excision, we reapproximate the edges with one or more interrupted sutures of chromic catgut

In some patients the fistulas may be so severe, extensive and chronically infected that simple excisions are not successful or even feasible Some of these patients actually have an entirely different condition such as hydroadenitis suppurativa, which is often best treated by wide excision of infected skin followed by split thickness skin grafting Here one may inject the draining openings with a blue dye or a radiopaque medium to demonstrate whether or not the tracts lead into the rectum Proximal colostomy, while theoretically valuable to "allow the infection to subside", actually accomplished little in two patients in which we tried it Six months and a year later the sinuses and fistulas were draining just as much pus as ever In some patients whose condition cannot be successfully managed surgically the chronic secondary scarring may produce stricture or sphincter incontinence In such individuals abscesses are drained as they occur

The *preoperative* and *postoperative details* for fistula-in ano are similar to those given for hemorrhoidectomy

PILONIDAL CYST (AND SINUS)

The pilonidal (inclusion) cyst contains hair in most instances It may present as an acute inflammation with abscess formation or as a draining sinus The dimple or pore is usually situated in the midline between the buttocks but well posterior to the anus, approximately over the lower sacrum or coccyx

The acute abscess is best managed conservatively, or simply incised and drained under local anesthesia The formal excision of the lesion is then deferred until acute inflammation is no longer present

Routine preoperative preparation includes an enema to avoid a bowel movement during the first 48 hours following surgery, to minimize fecal contamination of the wound until it is well sealed Of course, all surrounding hair is shaved

At surgery one excises the cyst and its finger-like projections and then either leaves the wound open or closes it We prefer to close the wound primarily It is often helpful in identifying the lateral extensions of the lesion to inject methylene blue into the sinus

tract before making the eliptical incision with which to excise the involved skin. One then keeps the dissection wide of any bluish discoloration, excising involved tissue down to the presacral fascia. Hemostasis and asepsis should be meticulous.

It is our experience that with complete excision of diseased tissue, prevention of hematoma and infection, and avoidance of undue tension on the suture line during the first two weeks postoperatively, few pilonidal wounds fail to heal *per primum*. The subcutaneous tissue is closed with fine catgut sutures to obliterate dead space and the skin is closed with silk or fine wire. Tape is applied transversely over the dressing so as to relieve tension on the suture line.

Postoperative measures which we consider important are, first and foremost, the prone position in bed or the standing position when out of bed (no sitting) for 10 days. Actually, the patient is discharged from the hospital in seven days, if the wound is clean and healing well. The skin sutures should be removed only after the skin margins appear to be securely united, for if bacteria gain access to the subcutaneous tissue the wound may well become infected. Second, the patient is not encouraged to have a bowel movement during the first 48 hours postoperatively but thereafter diet and elimination are allowed to proceed ad lib. Third, the dressing is changed often enough to prevent maceration of the skin. The wound is always redressed in such a manner that adhesive tape pulls the buttocks together and prevents tension on the suture line.

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(c) *History* of hernia that was down but is now not discernible (common in young teens where mother's word must often be taken)

(d) *Previous operation* for hernia or hydrocoele?

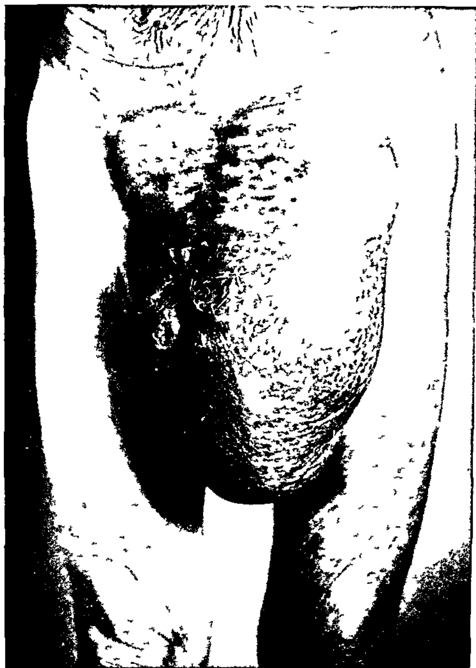


FIG 41—*Scrotal Hernia* A change in bowel habits may be due not to the presence of colon in the hernia but to the presence of cancer in the colon Barium enema is indicated Urinary obstruction and cough should be absent before repair is carried out and signed permission for removal of the testicle if indicated should be obtained Sliding hernias of more than minor extent are best managed with the aid of a separate abdominal incision above

(e) *Palpate* hernial sac (*silk sign*) in infants
(f) *Femoral hernia* present also?
(2) Rule out conditions which might lead to early recurrence
(a) Upper respiratory infection with *coughing*
(b) *Urinary obstruction* with straining Better to perform a needed prostatectomy first or (less satisfactory) to use prolonged catheter decompression following repair of incarcerated hernia requiring immediate surgery Dysuria is occasionally due to the presence of the bladder in a sliding hernia
(c) *Colon obstruction* leading to distention and/or straining at stool The dysfunction may be due to the presence of a loop of sigmoid colon in a large left inguinal hernia but it can also be due to obstruction by tumor
(d) *Permission* in writing for excision of the testicle in the occasional case where this may be removed to obtain a firm repair especially in very large and in certain recurrent defects
(e) *Treat intestinal obstruction* with usual preoperative alimentary tube suction fluid and blood replacement and antibiotics in patient who has incarcerated or strangulated bowel but operate with minimal delay
(3) *Reduce hernia* if early operation not feasible or advisable
(a) Place patient in Trendelenburg position
(b) Sedation usually with morphine
(c) Firm but not excessive pressure on mass from time to time to effect reduction Patient may be particularly adept at this himself if he has performed the maneuver frequently in the past Danger of reducing hernia *en bloc* with bowel still strangulated Gangrenous bowel is not easily reduced and gentle to moderate pressure to reduce the hernia is permissible where a reasonable degree of clinical judgement is exercised
(4) Consider preoperatively what special measures may be required for especially difficult repairs (Fascial graft? Tantalum mesh? Free full thickness skin graft?)

Operative Considerations

These are many, for the major distinguishing features among different hernias derive largely from the anatomy of various regions in which they occur and the surrounding structures thus available for use in repair A few precautions to be borne in mind with inguinal hernias may be listed

(1) Exposure of anatomic landmarks without unnecessary denuding of blood supply in fatty and areolar tissue
(2) Identification and retraction of vas deferens out of harm's way
(3) Preserve arterial and venous supply to testicle
(4) Preserve the iliohypogastric nerve
(5) Identify hernial sac (*may be minimal in direct defect*) and make certain that the pantaloon type of hernia does not exist To repair a direct hernia but leave an indirect sac is to invite early recurrence
(6) Ligate sac high and excise excess
(7) Repair of both inguinal rings (internal and external) in such a manner as to minimize recurrence at these points where it is most frequent
(8) Avoid strangulation of the cord which will produce testicular swelling and occasional atrophy

(9) Hemostasis and asepsis to prevent postoperative hematoma and/or infection both of these are prone to permit early recurrence
(10) Minimize contamination where necrotic bowel must be resected and remove sufficient bowel to be certain of clearly viable tissue to be used for the anastomosis We use a partial wire closure in many hernias and in all in which gangrenous bowel is resected
(11) An associated hydrocoele is removed

Postoperative Care

(1) Minimize coughing straining at urination and straining at stool
(2) Ambulatory as desired
(3) Antibiotics in probably contaminated (bowel resection) wound where the agent is also for protection against peritonitis Routine antibiotics unnecessary
(4) Testicular swelling which should be uncommon except in difficult scrotal hernias is treated with suspensory athletic supporter (*jockey strap*) or with supporting adhesive tape passed from the anterior surface of one thigh beneath the large scrotum to the anterior surface of the other thigh An ice bag or in some instances a hot water bottle is applied to the scrotum
Again however if meticulous hemostasis and careful preservation of cord blood supply are attended to during operation serious postoperative scrotal swelling is rare
(5) As a precautionary measure we advise the patient to lift nothing which weighs more than 20 pounds during the first three months postoperatively
(6) Pain (excessive or persistent) in the scrotum or operative site may be due to interference with regional nerves but it almost always subsides in a week or so
(7) Some hernia incisions (as well as those elsewhere) may spit silk sutures for prolonged period as a rule these are removed as they appear Formal reoperation is rarely required
(8) Prolonged *follow up* is an important part of hernia surgery

FEMORAL, VENTRAL AND DIAPHRAGMATIC HERNIAS

Femoral Hernias

The femoral hernia protrudes through the femoral canal, beneath the inguinal ligament and presents at the fossa ovalis adjacent to where the long saphenous vein enters the femoral vein It is more common in women than in men, but the inguinal hernia is still the most common type in both sexes Particular features of the femoral hernia are first, that the narrow and relatively unyielding opening of the femoral canal often produces bowel obstruction and not infrequently necrosis especially of the Richter's or tangential type Second, the femoral hernia is not nearly so apparent to the examiner as is the more superficially situated inguinal hernia, and the former is often overlooked

The repair of a femoral hernia is relatively simple, whether performed from below or above the inguinal ligament

Ventral Hernia

The ventral hernia is usually an "incisional" hernia and it most frequently presents in the midline below the umbilicus. Unfortunately, it is often met in obese women whose abdominal wall structures have been attenuated by multiple pregnancies and previous operations for repair. Preoperative measures are relatively few for it is only the occasional patient who can or will reduce her weight to facilitate surgery. Tantalum mesh may be required to bridge a defect which cannot otherwise be closed. Pneumoperitoneum or strapping of the abdomen so as to maintain reduction of abdominal viscera for a week preoperatively to permit respiratory adjustment to an increase in intra-abdominal pressure has been advised but we have rarely used it.

Operative problems have to do with the following:

(1) Care not to injure bowel adherent to the sac.
(2) Precise identification of the fascial margins of the defect without denuding them unnecessarily of blood supply.
(3) Secure closure of the defect (or multiple small defects usually converted to a single larger one) with whatever means are required; we frequently use interrupted wire sutures which pass through all layers except the skin.

Most such defects can be satisfactorily closed without a foreign material such as tantalum. The subcutaneous space is drained in obese patients, for a certain amount of fat necrosis with oil formation will occur even if infection is absent. Fat is fragile, has a poor blood supply and is especially prone to infection. *Postoperative care* is directed particularly toward minimizing distention and respiratory distress.

(1) Nasogastric suction until all ileus has passed.
(2) Nasal catheter oxygen therapy where dyspnea exists.
(3) Nothing by mouth until patient is passing gas freely and gaseous abdominal distention is absent and unlikely to occur or recur.
(4) Avoid bladder distention.
(5) Enema or laxative to prevent straining at stool.
(6) Deep breathing exercises to prevent pneumonitis which would both impair pulmonary ventilation and set off paroxysms of coughing and straining.
(7) Bed rest in many of these patients.
(8) Antibiotics prophylactically in the obese to minimize wound infection which so very often will lead to recurrence.

Diaphragmatic Hernias

Diaphragmatic hernias are of several types, including:

(1) Esophageal and para-esophageal.
(2) Traumatic (more frequent on the left because of the protective effect of the liver on the right).

(3) Inflammatory with necrosis (more common on the right because of the higher incidence of amebic and other abscesses there)
(4) Pleuroperitoneal (Bochdalek's) a large congenital defect Herniation more frequent on left because of protective role of liver on right
(5) Retrosternal (foramen of Morgagni)

Diaphragmatic hernias are most often detected because of cardiopulmonary embarrassment by the presence of abdominal viscera in the chest, or because of alimentary obstruction, pain, perforation or bleeding Some hernias are discovered incidentally on roentgen examination performed for other purposes The large pleuroperitoneal defect in the newborn is usually apparent on physical examination Otherwise, plain roentgen films aided by the insertion of a nasogastric tube with or without a barium swallow or barium enema, are required *Preoperative measures* vary with the individual case The suffocating infant may require almost immediate operative relief The adult patient with a "symptomatic" esophageal hernia should have a gastric analysis and gastrointestinal barium studies to rule out such additional lesions as duodenal ulceration with partial stenosis or a carcinoma of the stomach or colon A nasogastric tube is passed preoperatively for gastric decompression, a competent anesthetist is secured (above all, in infants), and blood is prepared for indicated transfusion *At operation* the herniated viscera are returned to the abdomen and the defect is repaired as indicated *Postoperative measures* are similar to those listed for ventral hernia, with the additional problem of management of the thoracotomy wound and drainage tubes (p 115) Since the esophagus or other elements of the alimentary tract are not usually opened, infection is not often a problem The results of precise and secure diaphragmatic repair are generally good

16 *The Liver, Gallbladder and Bile Ducts*

A SIGNIFICANT SEGMENT of general surgery is devoted to the management of diseases of the liver, gallbladder and common bile duct Moreover, the liver is the largest gland in the body and is the seat of many vital processes which permit survival Thus, the surgeon is interested not only in diseases of the liver and extrahepatic biliary tree *per se* but also in the physiologic state of the "normal" liver that must function adequately if the patient is to survive, for instance, an abdominoperineal resection

Some of the functions of the liver may be listed

(1) Prothrombin formation and other blood coagulation effects
(2) Plasma protein formation
(3) Protein fat and carbohydrate metabolism
(4) Blood pressure effects
(5) Hormone metabolism
(6) Bilirubin metabolism
(7) Bile salts formation
(8) Red cell metabolism (antianemic factor)
(9) Vitamin storage
(10) Detoxifying actions

In actual practice, it is unusual that liver function is evaluated by laboratory tests unless the history and physical examination have suggested the possibility of liver disease For this reason, very occasionally acute liver failure may be unexpectedly encountered following gastric resection, for example Nevertheless, the reserve function of the liver is so great that before hepatic failure has occurred physical signs and symptoms have usually developed to suggest the presence of liver disease In general liver function tests are requested when the patient is or has been jaundiced, or when esophageal varices, an enlarged spleen or (rarely) hemorrhoids suggest cirrhosis as the basic etiology of the probable portal hypertension Hepatomegaly should be investigated also

(3) Inflammatory with necrosis (more common on the right because of the higher incidence of amebic and other abscesses there)
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chills and jaundice—strongly suggests the presence of a *common duct stone* The gallbladder, if enlarged is apt to be tender Here the stools may be intermittently acholic as may the urine intermittently contain urobilinogen In this patient the serum alkaline phosphatase level may be elevated and the cephalin flocculation and thymol turbidity studies may be normal until weeks of extrahepatic biliary obstruction have produced biliary cirrhosis The patient with *carcinoma of the pancreas* may have all of these However, here the jaundice tends to be progressive, the stools remain constantly acholic no urobilinogen appears in the urine from time to time, the alkaline phospatase level usually rises steadily until a plateau is reached and evidence of hepatocellular damage as reflected by the flocculation studies appears late The gallbladder may be palpable but not especially tender The duodenal loop may be deformed and there may be occult blood in the stools *Common duct stricture* follows injury at biliary surgery in most instances

Itching (pruritis) is more common in obstructive jaundice than in hepatitis, but this differential feature is of limited assistance

Infectious hepatitis in contrast, produces early changes in the flocculation tests There is usually some pigment in the stools and urobilinogen in the urine The alkaline phosphatase level is characteristically within normal limits The liver may be enlarged and tender

Hemolytic jaundice must also be ruled out, but here there is abundant urobilinogen in the urine and pigment in the stools Increased red cell fragility may be demonstrated

Again, one more often reaches the correct diagnosis through an experienced analysis of all the data available, rather than on the basis of any one single test And with all tests he may be wrong fairly often unless he allows from 10 days to two weeks to pass while observing the patient whose diagnosis is in doubt for hepatitis may subside Once jaundice is absent, a cholecystogram may reveal gallbladder stones with the likelihood that common duct stones are present If an element of pancreatitis exists, the serum amylase level may be elevated A liver punch biopsy is helpful in some patients

PREPARATION FOR BILIARY SURGERY

Purely elective operations (other than those for hepato-biliary disease) are often wisely abandoned when serious liver impairment

DIAGNOSIS OF LIVER DISEASE

For practical purposes, as stated above, the problem most often presented in liver disease is that of distinguishing "surgical jaundice" from "medical jaundice." The former refers to mechanical obstruction of the common duct that might be relieved surgically, examples of which are common duct stone, pancreatic carcinoma and common duct stricture. The term "medical jaundice" refers to intrahepatic biliary obstruction due to viral hepatitis or portal cirrhosis, among other lesions.

While the history and the physical examination, with the aid of a few laboratory tests, will often permit an accurate differential diagnosis between hepatic and extrahepatic jaundice, often the question is eventually settled only by exploratory laparotomy. In the patient who is not jaundiced and whose liver function is being evaluated prior to portacaval shunt, there is usually a relative uncertainty regarding the specific nature of the pathologic process.

The *diagnosis* and the *differential diagnosis* of liver diseases may be considered in terms of whether or not jaundice is present. If no jaundice is present, any of a number of other clinical findings may still suggest that liver disease exists. These include hematemesis, melena, ascites, ankle edema, splenomegaly (often with secondary hypersplenism), perhaps hepatomegaly (at times with a lowered prothrombin level and ecchymoses), esophageal varices on esophagram, altered hair distribution, caput medusae and spider nevi. If these are present, the bromsulfalein test may be performed (in the absence of jaundice which interferes with the test). If there is a significantly greater than 10 per cent retention of the dye 45 minutes after intravenous injection, liver impairment is probable. If this finding is supported by collateral clinical and laboratory data, including a lowered serum albumin level with a reversal of the A/G ratio, impaired liver function is virtually certain. A lowered prothrombin level that does not become normal after a few days of vitamin K (20 mg. I.M. b.i.d.) also reflects functional liver impairment.

Differential Diagnosis of Jaundice. The *history* and the *physical examination* that includes a rectal specimen of feces for personal inspection constitute the primary data that permit the differentiation of "medical" from "surgical" jaundice where the distinction can be made. For example, the history of "gallbladder trouble"—perhaps associated with previous intermittent attacks of fever,

chills, and jaundice—strongly suggests the presence of a *common duct stone* The gallbladder, if enlarged is apt to be tender Here the stools may be intermittently acholic as may the urine intermittently contain urobilinogen In this patient the serum alkaline phosphatase level may be elevated and the cephalin flocculation and thymol turbidity studies may be normal until weeks of extrahepatic biliary obstruction have produced biliary cirrhosis The patient with *carcinoma of the pancreas* may have all of these However, here the jaundice tends to be progressive, the stools remain constantly acholic, no urobilinogen appears in the urine from time to time, the alkaline phospatase level usually rises steadily until a plateau is reached and evidence of hepatocellular damage as reflected by the flocculation studies appears late The gallbladder may be palpable but not especially tender The duodenal loop may be deformed and there may be occult blood in the stools *Common duct stricture* follows injury at biliary surgery in most instances

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is disclosed However, operations for the relief of jaundice or of portal hypertension often must be performed at a time when liver function is far below normal and may even be marginal It is not the purpose to discuss here the many variations of operations on the liver and biliary tract, but certain general principles apply to the preparation for all It is these which will be considered

For elective cholecystectomy in the patient who is not jaundiced special preparation is not required, and to obtain a prothrombin level or to give vitamin K routinely is unnecessary and expensive Of course, the presence or highly probable presence of gallstones will be established by cholecystography If "nonvisualization" of the gallbladder occurs, the study should be repeated with a double dose of the iodine-containing compound, for in some patients the second study will reveal a normally functioning organ without stones However, if nonvisualization is again met with the increased dose, gallstones will be found in the vast majority of such patients Occasionally poor liver function or inflammation around the cystic duct (in one patient due to a penetrating duodenal ulcer) may result in nonvisualization of the gallbladder on cholecystogram

Prior to surgery an x-ray casette should be placed beneath the jaundiced patient so that cholangiography can be performed during surgery if indicated Operative cholangiography is so helpful, so safe and so well established that there is no longer valid excuse for not employing this technic when common duct stones are found Blood transfusion is not required in the uneventful cholecystectomy, but at least 500 cc should be available in case of unexpected difficulties A Levin tube is often inserted the morning of operation to decompress the stomach postoperatively for 24 hours In this way epigastric discomfort, hiccups nausea or intermittent vomiting may be avoided

Preparation of the Jaundiced Patient for Surgery In addition to the careful studies designed to avoid surgery on a patient whose jaundice is due to viral hepatitis, certain important therapeutic measures are indicated Vitamin K (20 mg I M each day) is advisable to treat or to prevent prothrombin deficiency The appetite of such patients has often been poor for days or weeks, and an attractive high caloric high-protein diet should be urged to fortify the liver and other tissues for the coming surgery Liberal vitamin supplements are given empirically Blood transfusion is given if anemia exists

Postoperatively, when the obstruction has been corrected and the receding jaundice is associated with an improving appetite, therapeutic alimentation should be further stressed

BILIARY TRACT OPERATIONS

Adequate exposure of the structures surrounding the cystic and common ducts is essential This is true regardless of whether one is using a subcostal or a paramedian incision for the removal of either an acutely inflamed or a chronically diseased gallbladder Since there exists such a wide range of anatomic variations in the positions of the important structures in this area, it is far preferable to adopt a "look and see" policy rather than laboriously to memorize lists of possible anomalies This is not to imply, of course, that a familiarity with possible deviations may not be of assistance in the more rapid identification of the anatomic relationships that are present in the individual case Essentially, one must expose the cystic duct, cystic artery, common hepatic duct and common bile duct The hepatic artery need not be formally exposed, but it should be palpated to ascertain its position and course to avoid injury, especially to the right hepatic branch

Exposure is much facilitated by caudad retraction of the duodenum This tends to draw the junction of the cystic and common ducts from beneath the hilar area and into perpendicular view A second Deaver retractor is used to retract the stomach to the left and a third is used to retract the liver upward Exposure is further facilitated by vertical traction on the gallbladder or more specifically, on the infundibulum, this last maneuver, usually performed with a Kelly hemostat, renders incision of the peritoneum overlying the cystic artery particularly easy to carry out

The dilated common duct should be explored and operative cholangiography is most helpful in excluding or identifying residual calculi If a stone impacted in the ampulla of Vater cannot be removed from above, it should be approached through a longitudinal duodenotomy incision, which is then closed transversely

The gallbladder is most frequently removed from below upward, following ligation and division of the cystic duct and artery Bleeding points are ligated, and the gallbladder bed is closed with a continuous atraumatic suture of chromic catgut Special care is directed toward the identification and ligation of any accessory bile ducts entering the gallbladder directly Bile spillage from the organ is

is disclosed However, operations for the relief of jaundice or of portal hypertension often must be performed at a time when liver function is far below normal and may even be marginal It is not the purpose to discuss here the many variations of operations on the liver and biliary tract, but certain general principles apply to the preparation for all It is these which will be considered

For elective cholecystectomy in the patient who is not jaundiced special preparation is not required, and to obtain a prothrombin level or to give vitamin K routinely is unnecessary and expensive Of course, the presence or highly probable presence of gallstones will be established by cholecystography If "nonvisualization" of the gallbladder occurs, the study should be repeated with a double dose of the iodine-containing compound, for in some patients the second study will reveal a normally functioning organ without stones However, if nonvisualization is again met with the increased dose, gallstones will be found in the vast majority of such patients Occasionally poor liver function or inflammation around the cystic duct (in one patient due to a penetrating duodenal ulcer) may result in nonvisualization of the gallbladder on cholecystogram

Prior to surgery an x-ray casette should be placed beneath the jaundiced patient so that cholangiography can be performed during surgery if indicated Operative cholangiography is so helpful, so safe and so well established that there is no longer valid excuse for not employing this technic when common duct stones are found Blood transfusion is not required in the uneventful cholecystectomy, but at least 500 cc should be available in case of unexpected difficulties A Levin tube is often inserted the morning of operation to decompress the stomach postoperatively for 24 hours In this way epigastric discomfort, hiccups, nausea or intermittent vomiting may be avoided

Preparation of the Jaundiced Patient for Surgery In addition to the careful studies designed to avoid surgery on a patient whose jaundice is due to viral hepatitis certain important therapeutic measures are indicated Vitamin K (20 mg I M each day) is advisable to treat or to prevent prothrombin deficiency The appetite of such patients has often been poor for days or weeks, and an attractive high-caloric high protein diet should be urged to fortify the liver and other tissues for the coming surgery Liberal vitamin supplements are given empirically Blood transfusion is given if anemia exists

Postoperatively, when the obstruction has been corrected and the receding jaundice is associated with an improving appetite, therapeutic alimentation should be further stressed

BILIARY TRACT OPERATIONS

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prevented or minimized to lessen the risk of postoperative abscess formation Appendectomy may be performed if it can readily be carried out After hemostasis has been achieved and the sponge count is correct, drains are placed in the subhepatic space and the abdomen is closed In the absence of injury to surrounding structures, bile leakage or subsequent bleeding the convalescence of most patients is rapid and uneventful following cholecystectomy, with or without exploration of the common bile duct

Postoperative Care

The routine orders (p 65) are sufficient following simple cholecystectomy in the average patient

Nasogastric suction, as indicated previously, will often prevent nausea and/or vomiting The wound dressings are watched for an undue amount of bloody or bile-stained drainage and are changed as necessary The drains are shortened on the third P O D and removed entirely by the fifth P O D Skin sutures are removed on from the fifth to the seventh day Ambulation is begun on the first P O D The nasogastric tube is removed on the first P O D, and water is given by mouth that afternoon Thereafter liquids and then solid foods are given as rapidly as they are tolerated The patient is told that the rigid avoidance of fats (greasy foods) that he observed preoperatively to avoid further attacks of biliary colic can now be relaxed and in good time, abandoned We do not urge the patient to eat unlimited amounts of fat immediately, for we want him to be confident that his difficulty has been removed With this confidence he will not interpret every mild dyspeptic episode as indicating that his symptoms prior to surgery were erroneously diagnosed

If a *T-tube* was inserted it is connected to a drainage bottle and the postoperative cholangiogram may be performed as early as the sixth or seventh P O D The T-tube is preferably secured firmly to the abdominal dressings with the appropriate use of adhesive tape and safety pins

When a disconcerting amount of bile drains around the T-tube, it usually is an indication that the tube was too small for the size of the common duct and also that the common duct was not closed snugly around the long arm After about six days a cholangiogram may safely be performed and when it is the various unhappy possibilities that had beset the thoughts of the surgeon will usually be

dispelled while there is leakage around the long arm as the T-tube leaves the common duct the medium flows readily into the duodenum and no residual stones are visualized The T-tube is removed several days later, the common duct closes promptly and drainage ceases within from 48 to 72 hours in the absence of distal ductal obstruction

The *postoperative complications* that may at times occur are *hemorrhage* (perhaps from a branch of the cystic artery), profuse *bile drainage* due to the division of an accessory bile duct in the gallbladder bed to common duct injury or to failure to secure the cystic duct adequately, subhepatic or subdiaphragmatic *abscess* with pylephlebitis, ligation of the hepatic artery with *liver necrosis*, overlooked *common duct stone*, ascending *cholangitis, postcholecystectomy syndrome, pancreatitis* due to "false passage" inflicted with improper common duct probing or to other trauma, *wound infection* and *hernia formation* The development of jaundice may be due to hepatic failure, residual stone *common duct stricture* or pancreatitis

The complications noted above must of course, be dealt with individually If postoperative bleeding is excessive and continues, reoperation may be necessary (If the blood clots and platelets are present in adequate numbers the bleeding is probably due to an unligated vessel rather than to a defect in the clotting mechanism) With common duct injury there may be a profuse bile drainage for several weeks, and as the drainage ceases the patient becomes jaundiced This jaundice is often associated with ascending cholangitis which produces chills and fever

Intraperitoneal abscesses can be difficult to diagnose as can single or multiple intrahepatic abscesses Roentgen studies, aspiration with syringe and needle and exploratory laparotomy are variously used When it is suspected that the hepatic artery has been ligated, massive penicillin therapy should be given to inhibit the growth of anaerobic organisms within the liver, with such treatment the patient may well survive some considerable degree of liver necrosis, inasmuch as the liver continues to receive some oxygen through the large portal flow

The overlooked or residual common duct stone, discovered at routine postoperative cholangiogram, will pass in some instances and perhaps in many instances if given enough time (6 to 18

months) Of course, if the stone is producing jaundice or the patient has attacks of pancreatitis, a second operation will be required Pancreatitis is such a serious complication that when it occurs in association with common duct stones these should be removed

The *postcholecystectomy syndrome* consists of abdominal discomfort which is often quite similar to the symptoms for which cholecystectomy was performed This diagnosis actually is a "catch-all" for such unrelated pathology as residual common duct stone, common duct stricture, stenosis of the sphincter of Oddi, pancreatisis, malignancy or long cystic duct stump containing at times a small stone

PORTAL HYPERTENSION GASTROESOPHAGEAL HEMORRHAGE AND VENOUS SHUNTING PROCEDURES

Patients with cirrhosis and esophageal bleeding are not numerous in most communities, but they always seem common when one has the responsibility for their care They can be inordinately demanding of intense effort, merely to keep them alive In other words, the advanced cirrhotic with portal hypertension and esophageal bleeding is a critically ill individual in whom therapeutic gains are usually markedly limited and the ultimate outlook dismal

The Clinical Evaluation

In our experience the patient has often been a chronic alcoholic who may or may not have been told by a physician that he has cirrhosis He is admitted for mild to massive hematemesis, with blood in the stools Jaundice may be prominent The immediate problems are to control the bleeding restore the blood volume to a safe level with transfusions and to take precautions against the threat of hepatic coma It should be borne in mind that peptic ulcer is common in cirrhotics and that the hemorrhage may not be esophageal in origin

(There are, of course a number of causes of cirrhosis other than alcoholism, and there are causes of portal hypertension other than cirrhosis)

Therapeutic Measures

Immediate Steps

(1) Transfuse if required (*Liters* of blood may be vomited in a very few minutes)
(2) Insert Sengstaken Blakemore tube (FIG 42) to control bleeding

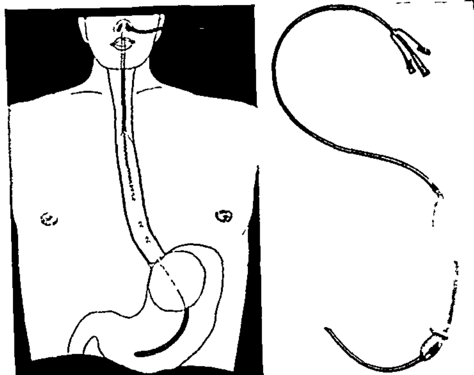


FIG 42—*The Sengstal en Blakemore Tube* \fter the tube has been passed through the nose and into the stomach the di tal or pherical balloon is inflated with about 200 cc of air the amount having been e timated by inflating a balloon to check for leaks prior to in ertion Traction of from 3 to 4 lbs is then exerted on the tube to bring this balloon firmly upward against the cardia Since the direction of flow in the bleeding esophageal varices is from below upward this maneuver should markedly reduce the esophageal bleeding In addition however the upper balloon is next inflated and maintained at a measured pressure (checked with blood pressure manometer) of about 20 mm Hg Finally the traction on the tube i sustained by means of a suitable head harness perhaps of plaster of Paris and a coat hanger The lower balloon mu t not be allowed to be regurgitated into the upper esophagus while inflated for pulmonary ventilation may be fatally interfered with

(3) Flush blood from alimentary tract with saline cathartic to reduce the risk of ammonia intoxication from ammonia formation in the bowel
(4) Oral antibiotics (streptomycin neomycin) to reduce bacterial flora and with it ammonia formation
(5) Vitamin K therapy (I M) to support prothrombin level as well as adequate amounts of other known vitamins
(6) Intravenous glucose
(7) Order complete liver function tudies The prothrombin level and the A/G ratio will be particularly significant if surgery is to be done Bromsulfalein retention marked?

Further Steps Once the patient is out of shock and further hemorrhage is temporarily prevented by the esophageal balloon, the internist-surgeon team has a chance to pause and examine the

total picture There are now essentially four moves to be considered, inasmuch as esophageal tamponade cannot be safely maintained for more than a few days (1) The esophageal balloon can be deflated at the end of perhaps 72 hours with the hope that bleeding will not recur, unfortunately, it often does (2) The intra-esophageal varices can be exposed transthoracically and ligated, as a limited emergency measure but not as definitive management (3) An emergency or delayed venous shunt (portacaval or splenorenal) can be carried out (4) The lower esophagus and upper stomach can be resected (rarely done at present)

Of these operations none strikes at the basic disease, the cirrhosis, and thus all are palliative with the limited but crucial objective of avoiding death from exsanguination Hepatic failure is not prevented, and this is the cause of death in many of these individuals

Preoperative Preparation for Portacaval Shunt

Certain measures employed were listed above, including those designed to maintain an adequate blood volume and to prevent ammonia intoxication However, once a shunting procedure is seriously contemplated the hepatic reserve becomes a matter of even more critical importance We did a transthoracic ligation of esophageal varices in a man whose total serum bilirubin level promptly rose from a preoperative value of 7 0 mg per cent to 19 mg per cent He had borderline hepatic reserve and his liver function never was adequate to permit a shunt procedure he died of recurrent esophageal hemorrhage weeks later

In brief, a lowered prothrombin level should respond to vitamin K therapy and rise to a value of at least 50 per cent of normal, if reasonable hepatic reserve is present For while coagulation defects may not occur even at levels much lower than this, one should not risk such bleeding—not to mention the limited hepatic function exhibited by the failure of the prothrombin level to return to normal on parenteral vitamin K Furthermore in the absence of jaundice a bromsulfalein retention of more than 40 per cent at the end of 45 minutes underscores the very serious risk of hepatic coma if portacaval shunt is performed Finally a reversal of the A/G ratio, with a serum albumin level of less than 2 7 Gm per cent, is also of poor prognostic import The presence of ascites does not necessarily contraindicate shunt surgery but it constitutes additional

evidence of serious hepatic disease Incidentally, ascites *per se* has been shown to produce an elevation of portal venous pressure

Actually, so very poor is the prognosis in severe bleeders unless some effective shunting procedure is done that we do not employ rigid rules of laboratory guidance as to which patients are to have surgery We reach this decision after total evaluation of the particular patient under consideration at the time

Immediately prior to surgery a percutaneous splenoportogram is performed to establish the presence of a patent portal vein If it is not available because of thrombosis, a splenorenal shunt is carried out following splenectomy, we prefer this operation for the acute bleeder

A rich experience with portal hypertension is recorded in certain of the appended references

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17 The Pancreas and Spleen

THE PANCREAS

The principal surgical lesions of the pancreas are functioning tumors of the islets of Langerhans, ampullary carcinoma, and the complications of pancreatisis The pancreas is relatively inaccessible —anatomically, physiologically, and roentgenologically— and the diagnosis of pancreatic disease is often arrived at late and by exclusion of other conditions

Diagnosis and Treatment of Functioning Islet Cell Tumors

Perhaps the single most important factor in the diagnosis of hyperinsulinism is the suspicion that it exists Organic hyperinsulinism may manifest itself in a variety of ways, but the most common one consists of the signs and symptoms which occur following an overdose of insulin The patient becomes nervous, perhaps with tremor, and eventually may exhibit coma and convulsions ("*epilepsy*") If the blood sugar is measured during an attack, which usually occurs several hours after the preceding meal, it will usually be found to be at a level below 60 mg per cent, perhaps from 20 to 30 mg per cent However individual patients vary markedly with respect to the level of hypoglycemia that precipitates an attack

Many patients exhibit bizarre mental aberrations, and psychoneurosis, drunkenness or even insanity may be diagnosed before the hypoglycemia is detected Most cases can be diagnosed if the possibility of organic hyperinsulinism is considered and the presence of Whipple's diagnostic triad is demonstrated The postulates of this triad are that (1) the patient must have "attacks" during a fasting period (often before breakfast) (2) the fasting blood sugar must be shown to be less than 60 mg per cent during an attack and (3) the attack must be relieved by carbohydrate therapy (usually in the form of intravenous glucose solution) When these three postulates are fulfilled a functioning adenoma of the islets of Langerhans will be found in most patients Whereas in the very occasional patient the excessive secretion of insulin may be due to

diffuse islet cell hyperplasia this diagnosis should not be accepted at operation until the entire pancreas has been adequately exposed and meticulously inspected and palpated for small tumors These tumors may be multiple in number and are usually brownish in color To accept the diagnosis of diffuse "hyperplasia" too readily is perhaps to overlook a functioning tumor which may later be demonstrated at autopsy An intravenous infusion of glucose solution will combat the hyperinsulinism during surgery

When a functioning tumor is suspected surgical exploration is indicated To attempt to control the hyperinsulism by dietary means often results in excessive obesity, and not to control the hypoglycemic attacks may result in serious brain damage

Postoperatively the fasting blood sugar level may rise to diabetic levels temporarily, requiring small doses of insulin for control However, this "diabetic" response subsides in a few days, and the patient is cured if an adenoma has not been overlooked and if the adenoma removed was not malignant

Carcinoma of the Pancreas

In reviewing the differential diagnosis of jaundice, mention was made of carcinoma of the pancreas, especially of the head of the pancreas and particularly of the ampullary region There is a growing tendency to operate only for ampullary carcinoma, since the results even here are poor and those of pancreatic resection for pancreatic carcinoma elsewhere in the organ are unacceptable

In brief, ampullary carcinoma usually is diagnosed only when it has occluded the common bile duct to produce jaundice The preoperative preparation is that outlined above for the jaundiced patient The operation most commonly performed is either a simple bypassing procedure, where the distended gallbladder or the common bile duct is anastomosed to the jejunum, or a pancreaticoduodenectomy (Whipple operation) There can be no doubt that in the very elderly, debilitated individual the bypassing procedure is the method of choice, it relieves the jaundice and itching improves the appetite, at least temporarily rehabilitates the patient, and has a low operative mortality In younger patients who are in fairly good general health, on the other hand there is still justification for the formidable pancreaticoduodenal resection, though here the total "hospital" mortality is probably somewhat in excess of 15 per cent in most hands and the 5 year survivors few

17 *The Pancreas and Spleen*

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thus introduce nutritive substances by this means However, where so much inflammation exists there is often partial obstruction of the upper small bowel, and the passage of a tube beyond the proximal jejunum is usually unsuccessful Antibiotics and the liberal use of blood transfusions are indicated Direct surgical attack on the fistula is not often attempted

Pancreatitis and Its Surgical Complications

In any patient with pancreatitis one must make certain that no gallstones or common duct obstruction due to stenosis of the sphincter of Oddi exists With the latter, surgical exploration may be required to establish or exclude the diagnosis However, surgical exploration is preferably not done during the acute attack of pancreatitis, since the operative mortality and morbidity are less when the condition is quiescent After the acute attack has subsided a calculous gallbladder is removed and the common duct explored Biliary tract surgery, when required, represents one of the few surgical measures that are effective in preventing further attacks of pancreatitis

Special measures may be required for the management of certain of the following complications of pancreatitis

(1) Shock from blood and fluid lo
(2) Pancreatic necrosis and ab ce s formation
(3) Jejunal obstruction
(4) Pseudocyst formation
(5) Obstructive jaundice
(6) Fistulas
(7) Pancreatic calcification
(8) Intractable pain

Shock The patient with severe *hemorrhagic pancreatitis* may lose many liters of bloody fluid into the peritoneal cavity and retroperitoneal space, and one must not be misled regarding the need for blood transfusion when the hematocrit level is found to be high Here the plasma loss has exceeded the red cell loss, but both will have been lost to a considerable degree as needle aspiration of the distended abdomen will demonstrate Therefore, very large amounts (10 L in 24 hours to maintain the blood pressure in one of our patients) of saline solution, plasma or plasma expander, and whole blood may be required The patient may survive the "shock period" only to die of massive retroperitoneal sepsis and necrosis If he survives the pancreatic and other tissue necrosis, he may eventually exhibit diabetes mellitus

Postoperative Care Following Whipple Operation Immediately after surgery it is advisable to re-evaluate the necessity for further blood transfusion In addition to routine postoperative orders the Levin tube is connected to suction, and a tube decompressing the common duct-enteric anastomosis is connected to a drainage bottle The wound dressings are inspected from time to time for excessive serosanguineous or frankly bloody drainage The nasogastric tube is removed on the third or fourth postoperative day, and water by mouth begun However, because of the nature of the anastomoses, it is well not to force solid food too rapidly Vitamin K and the transfusion of fresh blood will usually control postoperative oozing due to a lowered prothrombin level

Complications of pancreatico-duodenectomy are common and often fatal The most vicious complication is *pancreatic fistula* Such a development may be signaled by severe abdominal pain, shock or profuse bile stained drainage This may be due to a separation of the pancreatico enteric anastomosis, or to separation of one of the other anastomoses (stomach to jejunum or common duct to jejunum) which also allows the escape of pancreatic juice In addition to the peritonitis, tissue digestion and secondary hemorrhage which often follow pancreatic leakage the resulting inflammatory reaction may render oral alimentation impossible even when a defunctionalized (Roux-Y) loop was used for the pancreatico enteric anastomosis One can, of course, enter the left upper quadrant surgically and perform a jejunostomy for feeding purposes But even so, the jejunostomy affords a rather ineffective route for nutritional therapy, and pancreatic and enteric fistulas often prove lethal It has been estimated that a pancreatic fistula develops in perhaps from 15 to 20 per cent of cases and that from 30 to 50 per cent of those who develop the fistula will die Our experience certainly confirms the extremely serious nature of the combined pancreatico-enteric fistula

The following measures are used to treat a pancreatic fistula (1) nasogastric suction (2) catheter suction at the drain site to protect the skin of the abdominal wall and to assist in the evaluation of fluid losses, (3) aluminum paste and a heat lamp further to protect the skin and (4) intensive alimentation by the intravenous route and at times through a "feeding jejunostomy Occasionally one can pass a nasogastric tube beyond the point of leakage and

tion (external drainage), or anastomosis to stomach, duodenum or jejunum where a Roux-Y loop is preferred (internal drainage) Since the stomach often forms one wall of the false cyst, it is a simple matter to produce an opening into the cyst through the adherent portion of the stomach Despite the theoretical objection that food might collect in the cyst, this usually does not occur On G I series the barium can not often be demonstrated to pass into the cyst following cystogastrostomy

To anastomose the cyst to the duodenum is to risk a duodenal side fistula Such a defect permits the escape of duodenal secretions and pancreatic juice, and it precludes oral feeding Therefore we generally prefer an isolated (Roux-Y) jejunal loop for cysto-enteric anastomosis Should leakage occur the stomach and duodenum are still available for feeding, and the food can pass down an intact alimentary canal The pancreatic fistula will eventually close in most patients, though adequate external drainage should be provided at the original operation Of course, before a cyst is anastomosed or marsupialized one should make certain that tumor elements are not contained in its depth

Chronic Pancreatic Fistula A pure pancreatic fistula may close spontaneously However, it may not do so if it arises from a main pancreatic duct Under these circumstances either the portion of pancreas involved may be resected or the fistulous tract may be telescoped into an isolated (Roux-Y) jejunal loop Meanwhile, the skin of the abdomen must be protected The volume of fluid loss from most pure pancreatic fistulas is not sufficient to cause a significant degree of dehydration Rather, it is the nuisance of redressing the drainage site and the skin excoriation that are important in the chronic fistula

Intractable Pain Chronic relapsing pancreatitis is a fearful condition in its more vicious forms There may be necrosis, abscess formation jaundice and calcification However, it is the intractable pain which is so debilitating and demoralizing, it frequently leads to narcotic addiction and may even lead to suicide

Many different operations have been devised to prevent further recurrence of the attacks, but none is consistently successful In truth, the management of severe chronic relapsing pancreatitis remains an unsolved medical and surgical problem Division of the sympathetics is a relatively simple operation which affords a meas-

Corticosteroid therapy has not been definitely beneficial, in our experience

Pancreatic Necrosis and Abscess Formation This complication will at times necessitate surgical drainage If the abscess develops in the body and tail of the pancreas and presents as a mass in the left flank, retroperitoneal drainage is readily accomplished by a left flank incision When the abscess forms in the head of the pancreas, however, adequate drainage is much less easily achieved because of the proximity of vital structures which include the duodenum, common bile duct, main pancreatic duct, portal vein and superior mesenteric artery

Jejunal Obstruction In two patients admitted with jejunal obstruction of obscure etiology, the obstruction was found to be due to inflammatory constriction of the bowel by subacute pancreatitis near the ligament of Treitz The jejunum was dissected free of the pancreas, and the obstruction was permanently relieved

Pseudocyst Formation Pseudocysts may follow pancreatic inflammation due to trauma or the usual "acute pancreatitis" They may be associated with pain but perhaps more often they simply present as a silent epigastric mass (TABLE 17) They may be excised in some instances, but more often it constitutes good judgement to utilize some form of drainage procedure These include marsupializa

TABLE 17—*Silent Abdominal Mass Work Up*

1 HISTORY MAY AFFORD CLUES For example abdominal trauma leading to pseudocyst neurofibromatosis of skin suggesting retroperitoneal neurogenic sarcoma or masculinization suggesting adrenal tumor

2 PHYSICAL EXAMINATION Location mobility consistency of mass

3 ROENTGENOGRAMS TO EXCLUDE INTRINSIC LESIONS Gastrointestinal series barium enema and I V and retrograde pyelography

4 SOME DIAGNOSTIC POSSIBILITIES

a Upper Abdomen or Flank

i Pancreatic cyst

ii Mesenteric cyst

iii Liver spleen or cyst or other pathology of kidney

iv Retroperitoneal lipoma fibrosarcoma rhabdomyosarcoma neurogenic tumor adrenal tumor teratoma or aneurysm

b Lower Abdomen

i Ovarian cyst (may fill entire abdomen)

ii Fibroid

iii Hydrosalpinx

iv Pathology of alimentary tract not revealed on roentgenogram

v Bladder plus certain of those listed under upper abdomen

vi Cold abscess

5 MANAGEMENT Surgery indicated if mass not satisfactorily explained and/or made to regress by conservative measures

Splenectomy The removal of a very large spleen can go smoothly or it can occasion considerable anxiety First, two intravenous infusions should be running, to permit rapid blood transfusion if needed (A single infusion may suddenly fail to function at a most critical stage) Second, adequate exposure greatly simplifies matters If one is using a left subcostal incision, it may be extended far around toward the flank, thus permitting division of lateral adhesions under direct vision Third, blood loss is reduced by initial ligation and division of the splenic artery and the major veins of the hilum Injury to the splenic flexure of the colon, left kidney, tail of the pancreas and greater curvature of the stomach is avoided Major vessels are wisely ligated doubly, with a suture ligature on the splenic artery

Following removal of the organ the left subdiaphragmatic space is irrigated with saline solution and thorough hemostasis secured We usually then place drains in this area and bring them out through the lateral end of the incision

Postoperative Care

Most patients run a somewhat febrile course following splenectomy, but the cause of this fever has not been clearly demonstrated Abscess formation is not common, unless postoperative hemorrhage occurred The drains are removed in stages and are out entirely by the fifth P O D

The platelet count may rise to one million during the first week after surgery, and some surgeons employ anticoagulants to prevent thrombotic phenomena We do not The white count also rises, as does the red cell count in many individuals who were anemic preoperatively The elevated platelet count gradually declines over the next week or so

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TABLE 18—*Hypersplenism*

1 DIAGNOSIS Evaluation of bone marrow and peripheral blood elements
  a Primary Hypersplenism
    i Hemolytic anemia
    ii Thrombocytopenia
    iii Neutropenia
    iv Pancytopenia
  b Secondary Hypersplenism
    i Portal hypertension
    ii Splenomegaly due to such conditions as tuberculosis Gaucher's disease lymphoma etc
2 MANAGEMENT
  a Medical—with corticosteroids
  b Surgical—splenectomy if steroid therapy not effective or lasting
3 PREOPERATIVE MEASURES
  a Routine Check bone marrow
  b Adequate blood available for transfusion and adequate intravenous setup for rapid infusion if required
4 POSTOPERATIVE MEASURES
  a Routine
  b Remove drain in stages by 5th POD
  c Antibiotics
  d Repeat complete blood count (including platelets) q 2nd day
  e Anticoagulants if platelet count rises above 1 000 000?

ure of relief in some patients Operations to relieve common duct or pancreatic duct obstruction are important More recently total pancreatectomy has again been advanced as a means of definitive management Opiates are to be avoided because of the addiction hazard Finally, one will want to be certain that the pancreatic biopsies have not erroneously failed to demonstrate the infiltrating pancreatic carcinoma Carcinoma and pancreatitis may both be present

THE SPLEEN

Surgical indications for splenectomy are limited largely to the following (1) splenic trauma (2) idiopathic thrombocytopenic purpura, (3) congenital hemolytic anemia and (4) hypersplenism (other) due to portal hypertension blood dyscrasias or other conditions (TABLE 18)

Preoperative Preparation

The measures required are an accurate diagnostic work-up, the procurement of adequate amounts of compatible blood for the particular case and the insertion of a nasogastric tube with which to decompress the stomach at surgery In many patients the transfusion of fresh blood is indicated, whether to supply platelets or red cells If the patient has been having reactions to "compatible" blood transfusions, as not infrequently is the case in congenital hemolytic anemia, the use of intravenous ACTH may reduce the incidence and severity of such reactions Check marrow activity

to secrete the adrenal androgens and possibly some estrogenic materials Hypersecretion of these androgens results in the adrenogenital syndrome (pseudohermaphrodism) in females, and in macrogenitosomia precox and precocious puberty in male children

Hypersecretion of estrogens results in feminization in males

The adrenal medulla secretes epinephrine, norepinephrine and perhaps other substances

The diagnosis of cortical hyperfunction must begin with clinical data derived from the history and physical examination which suggest that adrenocortical hyperfunction exists For example, *Cushing's syndrome* would be suggested by truncal obesity, hirsutism, moon face, muscle wasting with weakness (the weak fat man) purplish striae, perhaps ecchymoses, amenorrhea and plasma chemistry alterations The diagnosis is confirmed by demonstrating an elevated plasma 17–21-hydroxycorticosteroid level, or one that is elevated above 60 gamma per cent (total, including both free and conjugated forms) after 25 units of ACTH have been infused over a 4 hour period The urinary excretion of corticoids is elevated, as is the excretion of 17-ketosteroids in many cases

In contrast, the *adrenogenital syndrome* affects primarily the genitalia, the secondary sex characters and the musculature That is, whereas Cushing's syndrome could be produced deliberately by giving large doses of hydrocortisone over an extended period, the adrenogenital syndrome would be produced by giving androgens such as testosterone to females Thus, the adrenogenital syndrome is manifested by enlargement of the clitoris (pseudohermaphrodism), a male pubic hair escutcheon that extends in a peak toward the umbilicus, amenorrhea, flat breasts, a husky voice, increased facial hair and a muscular build without the fat distribution which produces the usual female contours The urinary excretion of 17-ketosteroids is elevated (normal adult level, about 10 mg /24 hours) and, to a lesser degree, the excretion of corticoids may also be elevated However, whereas in Cushing's syndrome the hydrocortisone-like steroids predominate, in the adrenogenital syndrome the testosterone-like steroids have the ascendancy

The plasma electrolyte values are not nearly so helpful diagnostically as are the plasma and urinary steroid measurements It is true, however, that potassium loss in Cushing's syndrome tends to produce metabolic alkalosis

18 The Adrenal Glands

THE ADRENAL GLANDS, and in particular the adrenal cortices, occupy a highly important position in the response to surgery because of their far reaching effects on metabolism It is not surprising, therefore, that conditions of hyperfunction and hypofunction of the adrenal cortex should present variable and often highly complex clinical phenomena The correct interpretation of such phenomena, and the management of the underlying metabolic deviations which make them possible, constitute the basis of intelligent preoperative and postoperative treatment in the field

THE ADRENAL CORTEX

Diagnosis of Adrenocortical Hyperfunction

It is in the management of adrenocortical hyperfunction that surgery is usually required though nonfunctioning tumors do arise Therefore, it is useful to consider briefly the physiologic potentialities of the cortical steroids that may give rise to the manifold physical and biochemical phenomena which constitute the several more or less distinct syndromes

The adrenal cortex is divided into three rather well defined zones which actually constitute three organs in one, since the hormones produced are fairly specific for the zone in question The outer zone is the *zona glomerulosa* and it has to do primarily with the regulation of water and salt metabolism It is considered to be the probable source of aldosterone, and hyperfunction of this zone may produce the sodium retention and potassium derangements which are found in primary aldosteronism The middle zone is the *zona fasciculata*, and it is considered to be the chief source of the common corticosteroids such as cortisone and hydrocortisone, the glucocorticoids An excess of these steroids which regulate carbohydrate, protein, fat and, to an extent fluid metabolism, results in the diffuse metabolic changes met in Cushing s syndrome The inner zone is called the *zona reticularis* and the cells of this layer are considered

would not wish to treat a patient with a possibly malignant tumor with conservative methods— even if medical therapy were effective, which it is not

Preparation for Adrenalectomy

Let us assume that the patient has Cushing's syndrome (due to either adrenocortical hyperplasia or tumor) or the adrenogenital syndrome due to tumor Surgery is to be performed How should the patient be prepared for adrenalectomy?

As a rule the patient with the adrenogential syndrome will need no special preparation, other than the use of adequate amounts of hydrocortisone during and following adrenalectomy for removal of the tumor on the involved side In contrast the patient with Cushing's syndrome may be admitted in a state of advanced metabolic depletion For example a large potassium deficit may have resulted in hypokalemic metabolic alkalosis, and a liberal potassium intake will be required A high protein diet is also advantageous Since polycythemia may be present, preoperative blood transfusion may not be needed Even with Cushing's syndrome, however, relatively little corrective action is effective until the functioning tumor or most or all of the functioning hyperplastic tissue has been resected Vigorous corticosteroid replacement therapy is required in these patients

Subtotal Versus Total Adrenalectomy There still exists a considerable range of opinion concerning whether total or radical subtotal adrenalectomy should be done in the presence of hyperplasia that is causing Cushing's syndrome Total adrenalectomy does, of course, produce permanent absence of adrenal tissue, it renders the patient completely dependent on corticosteroid therapy While the effect of subtotal adrenalectomy for hyperadrenocorticism is similar to that for subtotal thyroidectomy for hyperthyroidism (namely, the reduction of the mass of functioning tissue without a reduction in the hormonal stimulus, ACTH or TSH, respectively) the results are less certain in the case of subtotal adrenalectomy The remaining "nubbin" of adrenal tissue around the central vein may enlarge, and the syndrome of hyperadrenocorticism may recur in some cases Thus, since unrelieved Cushing s syndrome is not compatible with a normal longevity, the availability of increasingly simple and effective replacement therapy has fostered an ever

The rare *feminizing syndrome* due to an estrogen secreting tumor in males is frequently due to a malignant tumor Only a few cases have been reported

Finally a wide range of partial or intermediate examples of endocrine dysfunction are encountered that cannot be readily classified into any of the main groups

Roentgen studies include a soft tissue film for visualization of an adrenal tumor, intravenous or retrograde pyelogram to rule out renal displacement, gastrointestinal series to disclose further an extrinsic mass, retroperitoneal oxygen or carbon dioxide insufflation to outline the kidney area, examination of the sella turcica for widening or erosion, and studies of bones elsewhere for osteoporosis

Management of Adrenocortical Hyperfunction

Both Cushing's syndrome and the adrenogenital syndrome are more often caused by adrenocortical hyperplasia than by adreno cortical tumors In the case of hyperplasia, the initial stimulus is derived from an increased rate of ACTH secretion by the pituitary gland However, it is now well established that a pituitary tumor is of itself incapable of producing "basophilism", it acts solely through the ACTH effect upon the adrenal cortex In the case of adrenocortical tumors, on the other hand, the hypersecretion of steroids derives from stimulus within the tumor itself, that is, neoplasia is autonomous and is little affected by ACTH, whereas hyperplasia results from the ACTH stimulus

Tumors of the adrenal must be removed, for they may be malignant The management of Cushing's syndrome due to hyperplasia differs from that of the adrenogenital syndrome that is due to hyperplasia Bilateral subtotal or total adrenalectomy is the treatment of choice in the management of Cushing's syndrome, since no medical therapy is effective With the adrenogenital syndrome, in contrast, the use of oral or parenteral cortisone or hydrocortisone will suppress the ACTH stimulus to the patient's adrenal cortices This results in a reduced secretion of adrenal androgens which is reflected in a diminished urinary excretion of 17-ketosteroids However, if the adrenogenital syndrome is due to tumor instead of to hyperplasia the level of 17 ketosteroid excretion in the urine will not decline to a normal level This is an important point in determining the management of the adrenogenital syndrome, for one

run its course The indications for the use of adrenocortical steroids immediately prior to, during and following surgery are now fairly well defined For the most part, they represent states of relative or absolute adrenocortical insufficiency, but certain other conditions, such as allergic states due to drugs or effects of certain poisons, may also respond to intravenous steroid therapy

The indiscriminate use of adrenocortical steroids, where there exists no reasonable possibility that they may be needed, simply imposes an additional complicating factor during what might otherwise be a purely routine postoperative recovery In contrast there is no substitute for adrenocortical replacement therapy when it is (infrequently) required

What Patients are likely to Need Adrenocortical Supplementation at Surgery?

A ABSOLUTE AND RELATIVE ADRENOCORTICAL INSUFFICIENCY

(1) Adrenalectomy (excision of tumor hyperplastic tissue, or of normal tissue for hypertension or malignancy)
(2) Adrenocortical hypofunction due to
  (a) Chronic Addisonian failure (tbc hypopituitarism 'primary etc)
  (b) Atrophy following prolonged cortisone therapy for a medical disease
  (c) Adrenal metastases especially in bronchogenic carcinoma
  (d) Severe infection (Waterhouse Friderichsen syndrome)
(3) Miscellaneous circumstances where additional adrenocortical effect may prove beneficial
  (a) Allergic reactions to blood protein hydrolysate pontocaine *etc*
  (b) Hypersplenism prior to and during surgery to permit platelets to rise and postoperatively when thrombocytopenia with bleeding has developed
  (c) In postoperative shock where there is no particular reason to suspect adrenocortical inadequacy but where blood replacement improved pulmonary ventilation and other measures have proved ineffective The occasional patient will respond to I V steroid therapy
  (d) Thyroid crisis
  (e) To prepare patients with certain diseases (*e g* ulcerative colitis) for surgery

How to Determine whether Adrenocortical Therapy is Required

A KNOWLEDGE OF FACTORS WHICH PREDISPOSE TO ADRENOCORTICAL INSUFFICIENCY

B EVIDENCE OF CHRONIC ADRENOCORTICAL FAILURE

(1) General appearance (including pigmentation and weight loss)
(2) Plasma chemistry values (low Na and Cl elevated K and N.P.N)

C SIGNS OF ACUTE ADRENOCORTICAL FAILURE

(1) Shock

more radical surgical approach to the management of Cushing's syndrome Many surgeons now prefer to perform bilateral total adrenalectomy Our preference still is to excise all of the right adrenal, and all but a small "nubbin" surrounding the central vein on the left If the condition recurs, the remainder of the left adrenal is easily located and excised at a second operation

PREOPERATIVE AND POSTOPERATIVE CARE OF PATIENTS NEEDING ADRENAL STEROID SUPPLEMENTATION

The use of corticosteroid replacement therapy in shock was mentioned in connection with the management of that condition The purpose here is to offer a more detailed outline of the general problem of adrenocortical replacement therapy in surgical patients

Background and Philosophy

The administration of adrenocortical steroid therapy to various patients coming to operation was begun on a broad scale when cortisone was made available Prior to this, the use of adrenocortical extract and *desoxycorticosterone* had been confined largely to patients having resection of adrenal tissue and more especially, those with a functioning adrenocortical tumor or hyperplasia that was producing Cushing's syndrome or virilism However, there had been early clinical studies involving the use of adrenocortical extract in the treatment of burn shock and other hypotensive states not clearly due to adrenocortical failure This use of the extract was not particularly rewarding and it was quite expensive

With the advent of relatively inexpensive cortisone, though, many surgeons employed the steroid in a wide variety of disease states as preparation for and support during operation For example, it was reported that debilitated subjects who were simply "not doing well" clinically could be substantially improved and rendered fit for surgery by a few days of cortisone therapy In fact, some even went so far as to state that all patients coming to major anesthesia should be given cortisone prophylactically in case some of them had unwittingly received prolonged steroid therapy for a medical condition such as arthritis Such an approach was, of course, both wasteful and otherwise impractical

Fortunately, this early period of perhaps justifiable exploration regarding the uses and limitations of a potent new drug has largely

run its course The indications for the use of adrenocortical steroids immediately prior to, during and following surgery are now fairly well defined For the most part, they represent states of relative or absolute adrenocortical insufficiency, but certain other conditions, such as allergic states due to drugs or effects of certain poisons, may also respond to intravenous steroid therapy

The indiscriminate use of adrenocortical steroids, where there exists no reasonable possibility that they may be needed, simply imposes an additional complicating factor during what might otherwise be a purely routine postoperative recovery In contrast, there is no substitute for adrenocortical replacement therapy when it is (infrequently) required

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(2) Plasma chemistry values (low Na and Cl elevated K and N.P.N)

C SIGNS OF ACUTE ADRENOCORTICAL FAILURE

(1) Shock

(2) Hyperthermia
(3) Tachycardia
(4) Apprehension followed by disorientation and later coma

This is a clinical diagnosis To await blood chemistry changes or plasma steroid determinations in acute failure may result in death of the patient

What Materials may be Used in Therapy?

A HYDROCORTISONE

(1) The current mainstay of operative adrenocortical steroid therapy
(2) Represents almost 85 per cent of normal adrenocortical secretion
(3) Possesses in various degree essentially all the multiple physiologic potentialities of adrenocortical hormones
(4) Has proved adequate simple and convenient in most instances
(5) Effect dissipated in about four hours following intravenous injection

B ACTH—UNDER SOME CIRCUMSTANCES

C CORTISONE PREDNISONE AND PREDNISOLONE

(1) Cortisone is less used than formerly It represents only a small fraction of the normal adrenocortical secretion and furthermore some believe it is first converted to hydrocortisone at the tissue level before it is utilized
(2) Prednisone and prednisolone represent newer analogues of cortisone and hydrocortisone respectively They possess a greater anti inflammatory effect than the parent compounds but produce less sodium retention and potassium and nitrogen loss In general they are currently used for long term medical therapy not for short term supplementation during and following surgery (dosage variable about 20 mg /day)

D ALDOSTERONE Water-electrolyte regulating hormone Not yet available in therapeutic amounts

E DESOXYCORTICOSTERONE Occasionally required when hydrocortisone does not produce an adequate effect on water and electrolyte metabolism (dosage 5 to 10 mg I M)

Hydrocortisone Therapy During and Immediately Following Operation

A DOSAGE

(1) For most patients 100 mg I V in a slow drip of saline or glucose solution given over each 8 hour period during the first 48 hours postoperatively is adequate Thereafter it is reduced
(2) If excessive fever and increasing pulse rate suggest insufficient dosage increase to 100 mg /6 hours

B SIDE EFFECTS

(1) There are relatively few serious side effects or sequelae of short term therapy before during and following surgery

How Long should Therapy be Continued and How Rapidly can it be Withdrawn?

A DURATION

(1) Depends on circumstances If given purely prophylactically in patient who *might* have adrenal hypofunction can usually reduce dosage rapidly after from 48 to 72 hours If used following adrenal resection must taper off more slowly and maintenance dosage may be required temporarily or permanently

B WITHDRAWAL FOLLOWING "ACUTE THERAPY

(1) Suggested schedule following major surgery
  (a) First 24 hours 100 mg I V /8 hours—300 mg /24 hours
  (b) Second day Same as first 24 hours
  (c) Third day Switch to 50 mg of hydrocortisone q 6 hours by mouth
  (d) Fourth day 25 mg of hydrocortisone q 6 hours P O
  (e) Fifth day 25 mg b i d P O
  (f) Sixth day Stop steroid therapy and follow clinical findings and plasma chemistry values Signs of acute failure (clinical diagnosis) or subacute or chronic failure (rising N.P.N., declining plasma sodium and chloride levels) require reinstitution of hydrocortisone therapy perhaps in association with ACTH (25 mg I M q.i.d) to stimulate the adrenal cortices

Finally, prolonged supervision by a physician is mandatory when borderline adrenocortical activity exists

THE ADRENAL MEDULLA MANAGEMENT OF PHEOCHROMOCYTOMA

The pheochromocytoma is a functioning tumor of the adrenal medulla which secretes epinephrine and norepinephrine In the typical case the condition is manifested by *paroxysmal attacks of hypertension* Associated may be headache, circumoral pallor, tremor, abdominal pain, or nausea and vomiting, in some patients all are present The attacks may be rare early in the disease, but as time passes they are apt to increase in both frequency and severity At times there may be associated upper gastrointestinal bleeding The attacks may be apparently spontaneous, or they may also be precipitated by some specific activity, such as position or by straining at stool Eventually the hypertension may become continuous

The *diagnosis* is established on the basis of history and physical examination, plain and special roentgen studies to delineate a retroperitoneal mass, and lysis of the hypertension by some drug such as Regitine or dibenamine At times a flank tumor may be palpated and, even if the tumor is not felt, palpation of the abdomen may precipitate a typical attack The plain film of the abdomen may disclose a soft tissue shadow above and medial to the kidney, or an intravenous pyelogram may reveal renal displacement However, the pheochromocytoma may be located almost anywhere in the abdomen or even in the thorax

For the confirmatory evidence afforded by sympatholytic drugs to be achieved, the patient must of course have hypertension at the time the drug is given by drip intravenously. A fall in the blood pressure to approximately normal levels constitutes a positive test. There do occur, of course, falsely positive tests, that is, a patient whose hypertension is "essential" and not due to pheochromocytoma may exhibit a decline in the blood pressure level. However, a positive Regitine test, when combined with positive collateral evidence, requires exclusion of a pheochromocytoma by laparotomy. More recently, the plasma levels of the catechol amines (representing epinephrine and norepinephrine) have been shown to be elevated during the characteristic hypertensive attacks. These determinations should render the diagnosis of pheochromocytoma much more precise.

There continues to be a considerable difference of opinion as to whether the shock-like state that may develop following removal of the pheochromocytoma is due to the acute heart failure from excessive amounts of epinephrine-like substances or to the withdrawal of such substances. Obviously this is a matter of therapeutic importance, since if the first explanation were true one would wish to use a sympatholytic drug (such as Regitine or dibenamine), and if the second hypothesis were true one would wish to give epinephrine therapeutically, tapering off the dosage gradually. We believe (but are not certain) that the phenomenon results from excessive amounts of sympathomimetic amines, and we advise that the blood pressure be maintained at reasonable levels throughout the induction of anesthesia and the subsequent surgery. This can be done by beginning a slow drip of either Regitine or dibenamine before the patient leaves his room for the operating suite, and continuing the infusion throughout operation.

Most pheochromocytomas are not malignant, and once they are successfully removed the patient is cured unless irreparable vascular damage has occurred. About 10 per cent of these tumors are bilateral and, again, they may occur at various sites within the abdomen or even in the chest. Neurofibromatosis may co-exist.

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19 *Preoperative and Postoperative Care of Infants: A Few Guides*

The purpose here will be to present a skeleton outline of some of the basic essentials which one must know in managing infants and young children before, during and following surgery For a more extensive and detailed coverage of preoperative and postoperative problems the monograph of Kiesewetter is recommended

FLUID AND BLOOD REQUIREMENTS

The infant must daily take in a volume of fluid that is approximately equal to one-half of his entire extracellular volume of perhaps 1500 cc , this is in marked contrast to the intake of an adult, which at 2500 cc would represent only one-sixth of the extracellular fluid volume Therefore, an adequate daily fluid intake is of critical importance in the sick infant, for his extracellular fluid reserves are sharply limited This is borne out by the fact that in the complete absence of water intake the infant may survive for only three or four days, whereas an adult may live for 10 days or more Vomiting, diarrhea, fever, trauma, simple dehydration or blood loss incident to operation are all serious causes of fluid disequilibrium in children

The volume of fluid replacement required in a dehydrated infant, perhaps *with hypertrophic pyloric stenosis, may be estimated on* the basis of *weight loss* and the *physical signs of dehydration* The general rules given previously (p 12) can be applied to children also, but greater care and continued observation are required to avoid underhydration or overhydration *Acid-base imbalance* develops more readily in infants because of their more fragile buffer systems and limited electrolyte reserves, and the treatment of alkalotic tetany or metabolic acidosis with an acidifying agent or an alkalizing agent, respectively, is more often required than in adults

In summary then, the *volume of water loss* is estimated on

For the confirmatory evidence afforded by sympatholytic drugs to be achieved, the patient must of course have hypertension at the time the drug is given by drip intravenously A fall in the blood pressure to approximately normal levels constitutes a positive test There do occur, of course, falsely positive tests, that is, a patient whose hypertension is "essential" and not due to pheochromocytoma may exhibit a decline in the blood pressure level However, a positive Regitine test, when combined with positive collateral evidence, requires exclusion of a pheochromocytoma by laparotomy More recently, the plasma levels of the catechol amines (representing epinephrine and norepinephrine) have been shown to be elevated during the characteristic hypertensive attacks These determinations should render the diagnosis of pheochromocytoma much more precise

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2 HARDY J D Pathophysiology in Surgery Baltimore Williams and Wilkins Co 1958
3 WILKINS L Hyperadrenocorticism Pediatrics *3* 533 1949

TABLE 21—*Daily Requirements per Square Meter of Body Surface Area*

	Water (ml)	Na (mEq)	K (mEq)	CHO (Gm)
Infant	1500	60	60	60-75
Ten year old	1500	60	60	60-75
Adult	1500	60	60	60-75

TABLE 22—*Approximate Normal Water Requirements*

Age	ml /kg /24 hr
3 days	80
3 months	130-140
3 months-2 years	100-125
4 years-6 years	90-100
10 years	75
18 years	50

60 ml 5% glucose in water supplies 3 Gm glucose minimum for protein sparing effect

TABLE 23—*Sodium and Potassium Requirements—24 Hours*

Age (Yr)	mEq Na + K	NaCl (Gm)	Saline Ringer s (cc)	Lact Ringer s (cc)	KCl (Gm)
½	17	1	110	130	
1	30	1 45	190	230	2
2-3	36	2	230	280	2 8
4-5	48	2 8	300	440	3 5
Adolescent	80	5 0	550	600	6 0

TABLE 24—*Sedatives for Infants and Children**

Age	Ave Wt (lbs)	Phenobarbital or Nembutal (mg)	Morphine (mg)	Demerol (mg)
Newborn	7			
6 mos	16	30		
1 yr	21	50	1 0	10
2 yrs	27	60	1 4	20
4 yrs	35	90	2 4	25
6 yrs	45	100	4 0	40
8 yrs	55	120	5 4	45
10 yrs	66	150	6 0	50
12 yrs	80	200	8 0	50

* From Gross R E The Surgery of Infancy and Childhood Philadelphia W B Saunders Co 1953

the basis of the history (*e g* , intake? urinary output?), measured weight loss, and other physical findings such as skin turgor (for marked dehydration, 8 per cent of body weight to be replaced with fluid, for moderate dehydration, 6 per cent, and for mild dehydration, 4 per cent) The *electrolyte* and *acid-base* derangements are estimated from determinations of the plasma sodium, chloride, CO_2 , and potassium levels

The fluid requirements for infants and children of different ages and sizes are expressed in various ways in TABLES 19–23 For the most

TABLE 19—*Body Surface Area (Infants)**

Body Weight Kg	Body Weight Lbs	Surface Area
1	2 2	10
2	4 4	15
3	6 6	20
4	8 8	25
5	11 0	29
6	13 2	33
7	15 4	38
8	17 6	42
9	19 8	45
10	22 0	49
15	33 0	64
20	44 0	82
25	55 0	95
30	66 0	1 11
35	77 0	1 23
40	88 0	1 34

* From Kiesewetter W B Pre and Postoperative Care in the Pediatric Surgical Patient Chicago Year Book Publishers Inc 1956

TABLE 20—*Homeostatic Limits in Parenteral Fluid Therapy**

	Floor	Ceiling
Glucose	75 Gm /sq m /24 hrs	350 Gm /sq m /24 hrs
Sodium	10 mEq /sq m /24 hrs	225 mEq /sq m /24 hrs
Chloride	10 mEq /sq m /24 hrs	225 mEq /sq m /24 hrs
Potassium	10 mEq /sq m /24 hrs	225 mEq /sq m /24 hrs
Phosphorus	0 3 Gm /sq m /24 hrs	2 0 Gm /sq m /24 hrs
Water	*0 7 cc /mOsm solute*	*10 0 cc /mOsm solute*
Water	900 cc /sq m /24 hrs	2700 cc /sq m /24 hrs

* From Talbot N B Crawford J D and Butler A M Homeostatic limits to safe parenteral fluid therapy New England J Med *248* 1100 1953

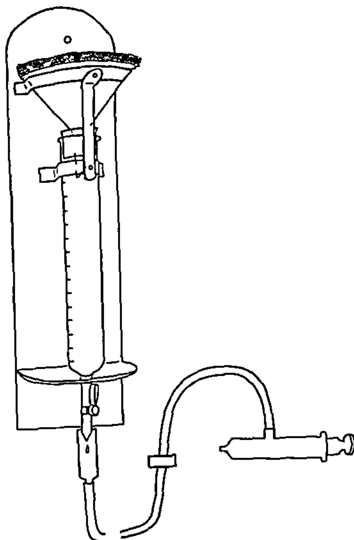


Fig 43—*Apparatus for Blood Transfusion in Infants* The volumes of blood infused in infants are small and must be precisely measured (After Smith R M Blood replacement in thoracic surgery for children J.A.M.A *161* 1124 1956)

warming mattress Take care to avoid a burn Water mattress for cooling where needed

(3) Appropriate incision for procedure
(4) Minimize handling of the bowel
(5) Maximum pulmonary ventilation possible particularly a problem during intrathoracic operations
(6) Instruments appropriate for situation
(7) Maintain adequate blood volume

POSTOPERATIVE CARE

(1) *Dressings* Subcuticular skin closure with application of collodion where feasible Nasogastric and other tubes must be carefully anchored with adhesive tape or

part these represent normal or average requirements, and the actual losses in the individual case with vomiting or diarrhea must be carefully evaluated and fluid replacement ordered accordingly

Blood replacement, whether for acute or chronic loss, is conducted along the lines presented previously (p 30) Preoperatively the hemoglobin and hematocrit levels are restored to reasonably adequate values (*e g*, 12 gm /100 cc blood) The infant may safely be transfused a volume of 10 cc /pound at one infusion Of course, if acute loss is occurring the volume lost is immediately replaced *This is best regulated by the use of dry sponges at surgery*, weighing them as they are discarded wet with blood, too, the blood aspirated from the operative field is collected in a graduated trap bottle and this volume is noted When one realizes that the total blood volume of the 3 Kg infant is only about 3 × 100 or 300 cc at most, the stark necessity of minimizing blood loss and of replacing loss as it occurs becomes crystal clear A suitable set-up with which to administer blood at surgery is shown in FIGURE 43

PREOPERATIVE MEASURES

(1) Diagnosis History physical examination and appropriate roentgen studies
(2) Gastrointestinal decompression with suction where indicated
(3) Fluid and blood replacement (FIG 43)
(4) Psychic preparation of the child preferably in concert with the parents
(5) A cut-down at the ankle where laparotomy or thoracotomy is planned
(6) Feedings of infant (bottle) continued until within 4 hours of surgery After the age of 2 they eat their last meal the evening before being allowed liquids up to midnight If operation is delayed the next morning for several hours a glucose infusion may be started at surgery Again it is wise to assume that all children admitted for emergency surgery have eaten recently regardless of what the mother believes surgery is postponed for 3 hours when possible
(7) Vitamin K (5 mg /day) is given to newborn and premature infants to combat a possible hypoprothrombinemia Vitamin C (25 to 75 mg /day P O or S c) is used to offset a scorbutic tendency and thus to improve wound healing
(8) Antibiotics or chemotherapeutic agents are often indicated where potential or actual infection exists (Gantrisin—60 mg /lb/24 hours penicillin—10 000 units/lb /24 hours intramuscularly streptomycin or Terramycin—20 mg /lb / 24 hours P O or I M Aureomycin—10 mg /lb /24 hours)
(9) Fever should be reduced below 102 F per rectum preoperatively (sedation aspirin in dosage of 100 mg P O or per rectum q 3 hours alcohol water sponging beneath an electric fan rehydration)
(10) Sedation as needed (TABLE 24)

OPERATIVE CONSIDERATIONS

(1) Competent anesthesia by one familiar with the problems involved
(2) Prevent excessive heat loss during surgery by use of warm water bottle or

atelectasis. Frequent gentle nasotracheal suction may be needed to assist the baby in clearing the major air passages. *Antibiotics* are employed routinely following laparotomy or thoracotomy in the very young.

(6) *Abdominal (intestinal) distention.* Vomiting of gastric content with aspiration of this material into the lungs and resultant pneumonitis is quite common in infants. In fact, in our experience it is one of the most prominent sources of postoperative mortality in the small infant. For this reason the stomach should be kept decompressed with either a small plastic or urethral (no. 10) catheter connected to gentle continuous suction.

(7) *Restraints.* The infant needs to be restrained only when an intravenous infusion is running or when he might molest a special dressing at a most critical stage of wound healing. There is an increased risk of pulmonary aspiration when a child is kept immobilized on his back with all four extremities secured.

GENERAL COMMENT

Far more than in adults, the preoperative and postoperative care of infants, especially regarding fluid replacement, for example, requires practical experience and refinement of technic. In fact, there is only a superficial resemblance between the intravenous administration of fluid to an adult as compared with the intravenous administration of fluid to a premature infant (FIG. 44).

Emergency surgery in children frequently has to do with either appendicitis or alimentary obstruction. The causes of obstruction in 110 consecutive cases are given in TABLE 25, and certain diagnostic considerations in TABLE 26.

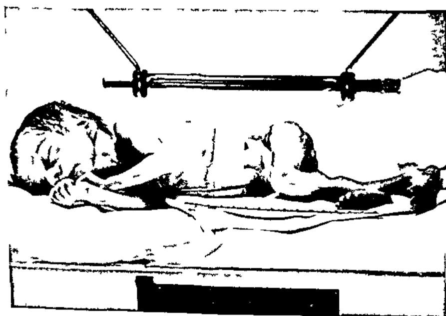


FIG. 44—*Premature Infant in Isolette.* Physiologic reserves are often minimal in such patients.

TABLE 25—*Causes of Alimentary Obstruction in Infants and Children**

		No	Average Age
Strangulated Inguinal Hernia		41	2 yrs
Congenital Hypertrophic Pyloric Stenosis		17	1 mo
Ileocecal Intussusception		16	6 mos
Anomalies of Rotation		6	1 mo
Undescended Cecum	5		
Volvulus of Small Bowel	1		
Adhesions		8	5 yrs
Postoperative	5		
Post peritonitis	3		
Congenital Atresia or Stenosis		6	2½ mos
Duodenum	3		
Ileum	2		
Jejunum	1		
Imperforate Anus		6	<1 day
Annular Pancreas		4	5 mos
Meckel s Diverticulum Obstructing Ileum		2	7 yrs
Hirschsprung s Disease with Obstruction		2	36 days
Colono colic Intussusception (Polyp)		1	4 yrs
Strangulated Umbilical Hernia		1	2 yrs
Total		110	

* From Wilson H Hardy J D and Farringer J L Jr Intestinal obstruction I Causes and management in infants and children Ann Surg *141* 778 1955

in some instances skin sutures to prevent their being pulled out by the infant Wounds that must be dressed are covered completely with adhesive tape

(2) *Sedation* Infants and children need either a barbiturate or morphine in appropriate dosage postoperatively (p 217) Morphine is perhaps a bit more hazardous than a barbiturate in the very young but it is quite satisfactory for children above 1 year of age

(3) *Fluids* There is a great reluctance to remove the cut-down at the end of operation for it does facilitate subsequent fluid administration Nevertheless it entails considerable risk of excessive hydration if for no other reason than that a constant drip is required to maintain patency of the plastic tubing within the vein Too the clamp regulating inflow may not function properly so that the entire intake calculated for the next 24 hours runs in within 2 hours Pulmonary edema may (and does!) result In general it is perhaps safer to remove the cut-down after the blood replacement has been achieved In any event it should not remain at one site for longer than 72 hours at most *Oral intake* is resumed as soon as possible and within 12 hours if laparotomy has not been performed

(4) *Vital signs* The character of the respirations and the rectal temperature are most important in infants Excessive fever may cause convulsions and is to be prevented by the measures outlined above

(5) *Respiratory problems* The major problems of the postoperative infant are often respiratory in nature—*whether due to laryngeal edema pneumonitis or*

20 *Neurosurgery, Urology, and Gynecology*

NEUROSURGERY

As WITH OTHER special types of surgery, neurosurgery requires the use of special knowledge, procedures, and instrumentation to achieve satisfactory results. In fact, to the intern the field of the neurosurgeon may appear to be a most difficult and confusing one. Nevertheless, there is an orderly series of steps which, if taken methodically, usually permits intelligent diagnosis and effective preoperative and postoperative care. In this respect, then, the neurosurgical work-up may be compared to the "standard" work-up of a urologic case or the series of procedures designed to identify the nature of a chest lesion. Since the purpose here is to emphasize problems which pertain to general surgery, the following neurosurgical considerations will be given in more or less outline form.

History and Physical Examination

In neurosurgery one is concerned with the identification of lesions which may be amenable to surgical correction and with the exclusion of those which are not. For example, hemiplegia due to cerebral hemorrhage is at times difficult to differentiate from a brain tumor, but the former would not be amenable to surgical therapy whereas the latter might be. Frequently treated lesions include neoplasms, traumatic hematomas (*e.g.*, subdural and epidural), infections (*e.g.*, brain abscess), aneurysms, congenital defects, Parkinsonism and less common conditions.

In general, of course, the clinical findings are largely related to changes in the nervous system. If the lesion is in the brain, both general and focal phenomena may be produced. General phenomena include certain of the signs of increased intracranial pressure (*e.g.* vomiting); focal signs include specific nerve losses which identify the probable anatomic location of the lesion. Spinal cord lesions produce, primarily, focal signs by virtue of nerve deficits.

TABLE 26—*Alimentary Obstruction in Infants Diagnostic Points*

1 Date of onset suggestive
  Immediately after birth
  a Atresia of duodenum jejunum ileum or colon
  b Malrotation volvulus of small bowel
  c Congenital bands or adhesions
  d Imperforate anus
  At two weeks or more
  a Hypertrophic pyloric stenosis (most common)
  b Annular pancreas
  c Undescended cecum
  After one month
  a Strangulated hernia
  b Intussusception
2 If vomitus contains bile obstruction is below ampulla of Vater
3 May pass meconium and still be obstructed
  (Farber test search center of stool microscopically for epithelial cells which have traversed bowel in utero)
4 Roentgenogram
  a Site of high obstruction usually indicated by distribution of gas in gastro intestinal tract If need contrast medium use Lipoidol or thin barium
  b If gas in colon invert infant to demonstrate distal extent of gas in low obstruction
  c Free air suggests perforation
  d Barium enema often helpful in ruling in or out colon obstruction or intussusception Absence of cecum from usual position suggests malrotation perhaps associated with other anomalies
  e Dilated small bowel but collapsed colon—atresia to be suspected
  f Granulated or 'ground glass' appearance suggests meconium ileus but may also be associated with low atresia

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Feeding of Infants

The following two simple formulas are recommended by Gross

(1)	Evaporated milk	6 oz
	Water	8 oz
	50% Karo (red label)	8 oz
	(= approximately 20 cal per oz)	
(2)	Whole milk	16 oz
	Water	2½ oz
	50% Karo (red label)	1½ oz
	(= approximately 20 cal per oz)	

Feedings are given on a *3* hour or 4 hour schedule in amounts to supply 2½ to 3 ounces (50 to 60 calories) per pound of body weight per *24* hours

REFERENCES

1 GROSS R E The Surgery of Infancy and Childhood Philadelphia W B Saunder Co 1953
2 KIESEWETTER W B Pre and Postoperative Care in the Pediatric Surgical Patient Chicago, Year Book Publishers Inc 1956

20 *Neurosurgery, Urology, and Gynecology*

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symptoms the probable anatomic position of the mass Most well known are the classic Jacksonian (motor) convulsions There is usually observed a series of clonic jerky movements which involve progressively different portions of the body on one side, because of the crossing of the pyramidal tracts, the convulsion on the right side of the body is the result of a cerebral lesion situated in the left half of the brain and vice versa These unilateral seizures may eventually involve both sides In addition, there are various other types of "seizures" which may be precipitated by a mass lesion or by a small but irritative lesion These cannot be detailed here but they include pain seizures (perhaps a sensation of pain in a part), seizures involving special senses (*e g*, visual, auditory, olfactory or gustatory, depending on the location of the lesion), and autonomic seizures such as yawning vomiting or changes in blood pressure, pulse rate or temperature There may be psychical seizures or hallucinations, where the patient "hears" sounds that are not present or where there are personality changes The signs of cerebellar dysfunction (*e g*, past-pointing, ataxia with deviation of gait to side of lesion, nystagmus) are familiar to most physicians

In contrast, rather than hyperactive motor seizures on the side opposite an increasing mass lesion, there may be motor or sensory hypoactivity The most commonly observed marked clinical example is the "stroke" or "apoplexy"

Signs and Symptoms of Spinal Cord Lesions

In general, the manifestations of spinal cord lesions of surgical importance are pain (localized or referred), motor weakness, sensory loss, diminished reflexes and muscle wasting

Further Diagnostic Procedures

Whereas a very great deal can often be learned from the history and physical examination regarding the presence, localization and even the possible nature of a brain lesion, certain additional measures are very helpful

Lumbar Puncture (FIG 45) While there are circumstances (particularly in the presence of evidence of markedly increased intracranial pressure) where lumbar puncture may be inadvisable, definite information is often gained The pressure should be carefully measured before fluid is withdrawn if it is elevated above 200 mm (of C S F fluid) only enough fluid for microscopic examination

Signs and Symptoms of Brain Lesions

Increased Intracranial Pressure (Acute) When the intracranial pressure is acutely increased there is not time for many of the phenomena associated with a chronic increase to develop Most prominent are severe headache which may precede coma and changes in vital signs ($\uparrow$ body temperature, $\downarrow$ pulse rate, $\downarrow$ respiratory rate, and a rise and later a fall in the blood pressure)

Increased Intracranial Pressure (Chronic)

Headache In the early stages of the development of a mass lesion within the unyielding bony confines of the cranium, pain may not be severe In fact, more often headache of minor or moderate degree may have been present for weeks or months before its persistence and severity drive the patient and his physician to take steps beyond the use of symptomatic medication such as aspirin with or without codeine Fairly characteristically the headache is especially noticeable on arising in the morning (due to altering cerebrospinal fluid pressure dynamics?), in contrast to "tension" or sinus headaches which more commonly develop later in the day

Vomiting Headache and vomiting usually without nausea, are classic phenomena of increased intracranial pressure and should always prompt at least an examination of the eyegrounds

Papilledema The choked (optic) disc affords the most readily detected confirmatory evidence of the chronically increased intracranial pressure suggested by headache and vomiting The elevation of the disc margins is often associated with hemorrhages and exudates *Visual field defects* will often be present but will vary with the anatomic location of the tumor and with the amount of temporary or permanent damage suffered by the fibers of the optic nerves due to the increased intracranial pressure

Diplopia Double images are of course, due usually to weakness of one or more of the extraocular muscles The abducens nerve (VI) is the one most frequently affected Initially the defect is slight and only the subjective diplopia is detected Late, however, squint may be apparent to the examiner

Focal Phenomena In addition to the above general evidence of a mass or space occupying lesion within the cranial cavity (which might be due to simple edema), localized specific lesions such as aneurysm, abscess, tumor or hematoma may produce focal or localizing phenomena that enable one to determine from the signs and

Roentgenography

Plain Skull Films. The trained specialist is required for the interpretation of the finer details of head roentgenography, but certain abnormalities can be detected by the less experienced. For example, an obvious skull fracture may be visible, or a calcified pineal gland may be seen to have been displaced laterally away from a mass lesion. If fontanelles have not entirely closed, the head may enlarge. The sella turcica may be eroded, especially the dorsum sellae in the presence of a pituitary tumor.

Intracranial Angiography. Many neurosurgical services now proceed from plain skull films directly to percutaneous carotid angiography. The contrast medium employed is often 35 per cent Urokon or Diodrast. From 10 to 20 cc. are rapidly injected and, as a rule, the internal carotid artery and its branches on the injected side are well outlined. The types of information sought are, first, aneurysmal dilatation of a branch; second, occlusion of a branch; third, displacement of branches by mass lesions. Depending on the displacement of the anterior, middle or posterior cerebral branches, one may localize the site of the mass lesion. Extravasation of the medium may disclose a ruptured aneurysm.

Pneumoencephalography. The ventricles, cisternae and cerebral sulci may be filled with air and thus outlined for "contrast" visualization by one of two methods. If the C.S.F. pressure is not significantly elevated at lumbar puncture, one may withdraw the fluid and replace it with air. With the patient in a sitting position the air will rise and, in many instances, fill even the lateral ventricles. However, if obstruction is present along the outflow tract of the C.S.F. from the choroid plexuses in the ventricles, the visualization of the lateral ventricles will not be accomplished. An alternative method—and the one generally used where increased intracranial pressure exists—is ventriculography. Here burr holes are placed and the air is introduced directly into one or both of the lateral ventricles. This represents more of an undertaking than does introduction of air by the spinal route, since it involves a surgical procedure. However, ventriculography does avoid the hazard of reducing the pressure of the spinal fluid when that in the skull may remain elevated and force the brain stem into the foramen magnum.

By whichever route the ventricles are filled with air to permit their visualization, the location of a mass lesion can be identified

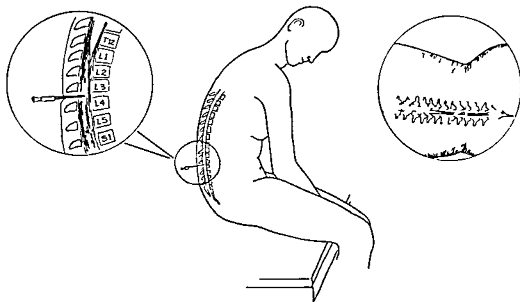


FIG 45—*Lumbar puncture* can be performed with the patient in either the sitting or the lateral decubitus position If there is reason to suspect a marked increase in cerebrospinal fluid pressure neurological consultation should be requested

should be removed Moreover, if headache and papilledema have already suggested the presence of increased intracranial pressure, a fine needle should be used to minimize the size of the perforation of the nonelastic dura (further leakage of spinal fluid following withdrawal of the needle is considered to be the commonest cause of postspinal headache) If the pressure is abruptly reduced, downward movement of the brain may result in fatal compression of the brain stem Many neurosurgeons prefer to place burr holes, from which cerebrospinal fluid may be removed by ventricular tap, rather than to risk spinal puncture

In general the following data may be gained from the lumbar puncture (1) the diagnosis of increased C S F pressure, (2) the red cell count which, if increased in the absence of a "bloody tap," may disclose subarachnoid hemorrhage, (3) elevated white cell count (if polys suspect abscess with meningitis—if lymphocytes, suspect possible brain tumor) (4) elevated total protein content which, if greater than 100 mg per cent, may be due to a brain tumor, (5) tumor cells may be identified by a trained cytologist if the neoplasm has penetrated the meninges, (6) the sugar content (normal, 50 to 80 mg per cent) and chloride content (normal, 119 to 128 mEq /L) may be reduced in purulent meningitis

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By whichever route the ventricles are filled with air to permit their visualization, the location of a mass lesion can be identified

in many or most instances by virtue of the indentation or displacement of one or another of the ventricles Whereas lumbar pneumoencephalography may be performed as a part of a routine work-up of the patient suspected of having a mass lesion of the brain, the ventriculogram is often performed immediately prior to an anticipated formal craniotomy, if indicated

Myelogram The subarachnoid space can be outlined with a radiopaque substance to demonstrate partial or total obstruction by a tumor, fracture or herniated intervertebral disc

The Electroencephalogram (EEG) The electroencephalogram is an integral part of the work-up of the patient who manifests intracranial pathology which may or may not be amenable to surgical attack Either increased or diminished electrical activity may be recorded over the lesion Unequal electrical activity between the two cerebral hemispheres is, again, important evidence that intracranial pathology exists An expert is required to interpret accurately the electroencephalogram which is nonspecific at best, that is, the tracings suggest that pathology is present but they do not identify the nature of the disease

UROLOGY

Renal Disease

Routine Evaluation (see p 7)

Urinalysis Pyuria and hematuria (TABLE 28) are very important findings in urologic patients However, these data are significant only when the specimen has been properly collected for study In males a satisfactory specimen for routine analysis and culture can be obtained by first cleansing the meatus with green soap and then collecting the urine after the first few cc have been voided In females a negative voided specimen is significant but a positive voided specimen is not significant Females should not be catheterized, however, except where the voided specimen has exhibited positive findings, for unnecessary catheterization often causes unnecessary cystitis A consistently low specific gravity must be carefully evaluated with the aid of appropriate renal function tests

Blood Chemistry N P N creatinine "CO_2", Cl, Na, K, P, Ca, uric acid and alkaline phosphatase if stones are present

Renal Function Tests The P S P urea clearance and concentration tests are frequently indicated The intravenous pyelogram pro-

TABLE 27—*Causes of Hematuria and Pyuria**

1 HEMATURIA Nephritis, stone tumor, trauma polycystic disease stricture acute or chronic cystitis (with or without ulceration) foreign body urethritis, pyonephrosis, tuberculosis pyelonephritis infected hydronephrosis and systemic causes (e g purpura hemophilia leukemia scurvy drug poisoning etc)	2 PYURIA Contracted bladder neck median bar, cystitis pelvic stone perirenal suppuration invading urinary tract spinal disease (Pott s etc) prostatitis prostatic abscess, pyelonephritis pyonephrosis, renal tumor, seminal vesiculitis urethral stricture, renal tuberculosis, ureteral stone urethral stone

* Modified from Campbell M F Principles of Urology Philadelphia W B Saunders Co 1957

vides a fairly good indication of the concentrating powers of the kidneys The introduction of ureteral catheters at cystoscopy will permit differential study and evaluation both as regards function tests and urinalysis The color intensity of intravenously injected indigo carmine as it appears at the ureteral orifices during cystoscopy affords valuable information, a deep bluish hue indicates at least fair renal function on the side being visualized

Roentgen Studies Renal stones are visible on the plain roentgen study in perhaps 80 per cent of cases Intravenous and retrograde pyelography provide information regarding renal and ureteral function, pathology and the presence of both kidneys Aortography has been employed with increasing frequency to demonstrate both renal and adrenal pathology

Bladder or Prostatic Disease

(1) Is obstructive uropathy present?
  (a) Decompress urinary tract (with catheter where possible FIGURE 46)
  (b) Evaluate renal function and pathology (see above)
(2) Biopsy bladder tumor at cystoscopy or prostatic carcinoma with punch biopsy (if indicated)
(3) Search for skeletal metastases if tumor suspected Order acid and alkaline phosphatase levels if prostatic carcinoma is suspected
(4) If patient is not admitted in acute urinary retention insert indwelling catheter (FIG 46) if residual urine is greater than 200 ml Place all such catheterized patients on Gantrisin for several days prior to prostatic surgery
(5) Bilateral vasosection is performed prior to prostatectomy by many urologists
(6) Special permission must be secured prior to orchiectomy
(7) If total cystectomy for carcinoma is contemplated the bowel should be prepared for uretero intestinal anastomosis These measures include a low residue diet gentle saline cathartics an oral antibiotic such as streptomycin or neomycin and preoperative enemas until returns are clear

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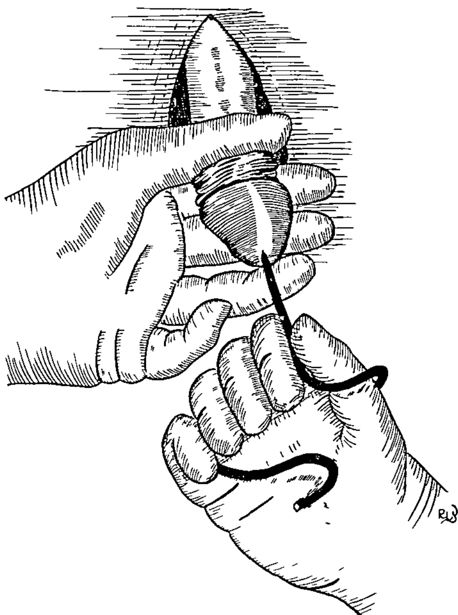


FIG 46—*Catheterization* is to be avoided except where clearly necessary. If repeated catheterization is likely to be required a Foley indwelling catheter should be inserted and left in place. Bladder urine is usually sterile and the positive urine culture may have been derived from the urethra. Urinary tract infection constitutes a common and important postoperative complication. Gantrisin is safe and is frequently effective.

GYNECOLOGY

Preoperative Care

The principal considerations which set gynecologic procedures apart from other operations which involve the lower abdomen are

the measures which are used to achieve accurate preoperative diagnosis

The *history* and *physical examination* include particular emphasis on the gynecologic features in question The menstrual history is especially important as is the existence of a vaginal discharge The cervical smear and/or culture may disclose uterine cancer or gonorrheal infection If the cell study is suggestive of tumor, formal cervical biopsy in four quadrants (with conization of the cervix and/or *dilatation* and *curettage of the uterus* where indicated) should be performed Possible pregnancy may be confirmed by appropriate tests for this condition Prior to hysterectomy all psychologic marital, and general and local pathologic considerations should be carefully evaluated and the indications for surgery clearly established

Postoperative care is not especially different from that for other abdominal operations Since the alimentary tract has usually not been opened, bowel function is generally re-established promptly Bladder and ureteral injuries are not rare in association with hysterectomy, and small bowel obstruction may result from adhesions to the sutured peritoneum at the pelvic floor As with all operations in the area, operations on the perineum are often associated with temporary inability to void Thrombophlebitis of the deep veins of the leg follows gynecologic surgery in a fair number of instances

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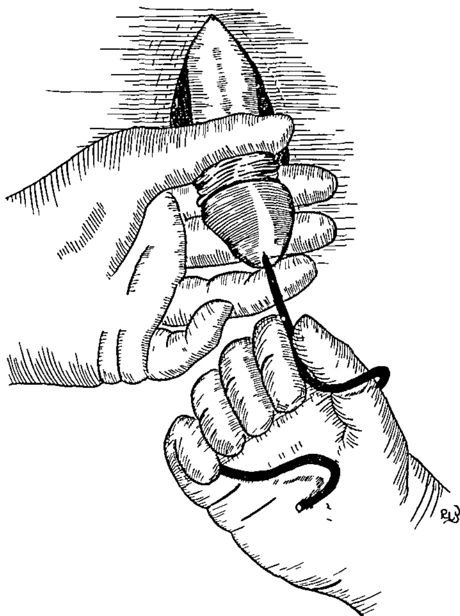


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Preoperative Care

The principal considerations which set gynecologic procedures apart from other operations which involve the lower abdomen are

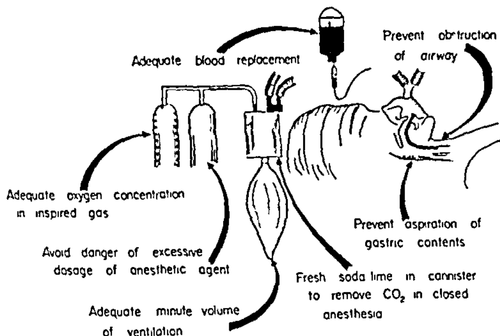


FIG 47—Careful attention to a few safety precautions vastly reduces the risk of general anesthesia

promote the safe induction, maintenance and recovery from anesthesia (FIG 47)

PHYSIOLOGY OF ANESTHESIA

General Anesthesia The agent to be inhaled or given intravenously must be introduced in sufficient concentration to produce cerebral narcosis This means that in the case of inhalation agents the concentration of the gas in the pulmonary alveoli must be higher than that in the blood during induction, essentially equal during maintenance, and below the blood concentration during recovery That is, during induction the gradient favors the flow of the gas from the inspired air into the blood, during recovery the gradient favors the movement of the anesthetic agent from the tissues to the lungs to be exhaled At first the storage of the anesthetic agent (inhalation or intravenous) in the depot tissues is low, but the accumulation of ether or thiopental in body fat steadily increases until the concentration approaches that in the blood Thus, the longer the duration of anesthesia the greater the storage effect is likely to be, and the greater the length of time required for complete recovery from narcosis

In the case of inhalation agents, excretion is effected largely

21 *The Safe Use of Anesthesia*

THE SURGEON AND ANESTHESIA

THE SIGNAL importance of anesthesia in modern surgical practice is acknowledged by all In many poor risk patients the hazards attendant upon the anesthesia may exceed the risk of the operation itself—if, indeed, it were possible ever clearly to separate the two Actually, in the conduct of the technical surgery one must not ignore the problems which the conduct of the anesthesia may entail And herein lies the need and the essence of co-operation between the anesthetist and the surgeon

The surgeon must comprehend the peculiar difficulties which the anesthetist may encounter Because of this, all surgical residents should rotate through anesthesiology for a period of three months This amount of time is well spent by men in surgical training They become "associates" with the personnel of the department of anesthesiology They develop a deep and abiding respect for, and appreciation of, anesthesiology as a specialty They learn how to employ a "gas machine," and the problems of defective ventilation and other aspects of gas exchange become a part of their daily surgical thought Finally, our residents have many times been called upon in anesthetic or respiratory emergencies of one sort or another and their training by the members of the anesthesia department has seen them through

PRESENT OBJECTIVES

The following discussion is not concerned with technical details of anesthesia which are the primary responsibility of the anesthetist Rather the objective is to present certain basic principles on which virtually all surgeons and anesthesiologists can agree To venture beyond this perimeter of firm agreement on established facts would be to stray into those unsettled areas of conflicting opinion in which the art of anesthesia becomes a factor in "anesthetic judgement" Thus we shall confine this presentation to a consideration of certain physiologic principles and factors which

permit such pooling of blood that the previously normal blood volume is now inadequate to fill the increased vascular bed Such a fall in blood pressure is not too serious in younger individuals, for it usually responds promptly to a neosynephrine drip However, in elderly or previously hypertensive patients more serious consequences such as myocardial infarction, anuria or hemiplegia may occur It has been our experience, though, that anesthesiologists who are thoroughly conversant with spinal anesthesia are more likely to consider it safe for more patients than are anesthesiologists who rarely use it

Another hazard of spinal anesthesia is *respiratory paralysis* due to an excessively high level We recall a young football player who had received a spinal anesthetic for laparotomy A satisfactory level of anesthesia did not develop and after an interval of waiting the anesthesiologist decided to do a second lumbar puncture and inject another dose of drug equal to the first Unfortunately, shortly after this injection the patient abruptly ceased breathing and did not resume for several hours, meanwhile, life was maintained with artificial pulmonary ventilation, facilitated by the use of an endotracheal tube

Late sequelae are *postspinal headache* and *nerve deficits* that range from abducens paralysis to transverse myelitis and paraplegia Happily, with the exception of postspinal headache these complications are rare In fact paraplegia is surely far less common than is death from defective general anesthesia The great difference is that the paraplegic lives on as a constant reminder The writer has never seen an instance of paraplegia from transverse myelitis due to spinal anesthesia, but he has seen one case of paralysis due to an abscess at the site of injection

Postspinal headache can be very annoying to the surgeon and quite incapacitating to the patient It is generally considered to result from leakage of spinal fluid through the perforation in the dura Its incidence is less when a fine needle is used for the lumbar puncture One may perform hemorrhoidectomy only to have the patient remain confined to bed for several days with headache which develops whenever the upright position is assumed Yet, this is uncommon

Local Anesthesia Skillfully used local anesthesia is very advantageous in many circumstances and should be more used

through the lungs This affords a safety factor that is not available when intravenous thiopental (Pentothal) is used Whereas the depth of anesthesia can be reduced by switching off the inhalation agent and hyperventilating the patient, the thiopental that has been injected cannot be reclaimed The patient must either metabolize or excrete it, and this may require many hours, especially if liver function is impaired The important consideration is, then, to achieve an even descent through the stages of anesthesia, using no more of the agent than is needed to produce satisfactory surgical (third stage) anesthesia By and large, the deeper the anesthesia, the greater the risk of complications such as hypoxia and hypercapnia which predispose to cardiac arrest

Spinal Anesthesia The injection of various local anesthetic agents into the subarachnoid space to interrupt nerve impulses below the uppermost point reached by the drug is widely used In fact, this technic predominates in certain geographical areas of the United States, and whether or not it is frequently used often appears to depend on the availability of anesthesiologists, for nurse anesthetists usually employ general anesthesia unless the surgeon himself gives the spinal

Agents for spinal anesthesia are or can be rendered, either *hypobaric*, meaning lighter than the spinal fluid, or *hyperbaric*, meaning heavier than spinal fluid To raise the level of anesthesia with an hypobaric solution the patient's trunk is elevated, with the hyperbaric solution, he is placed temporarily in the Trendelenburg position When the anesthesia has reached the desired level, as detected with pin prick, the patient is placed in the horizontal position Within a few minutes the agent becomes fixed, and thereafter tilting has little further effect on the level of anesthesia

The usual spinal anesthetic lasts for from 1½ to 2½ hours, but the addition of epinephrine to the solution will prolong its effect If it is known in advance that several hours of anesthesia will be required, one can insert and leave in place a plastic catheter and give additional doses or injections from time to time as needed

The *hazards* and *complications* of spinal anesthesia are relatively few but they can be serious The most common complication is *hypotension*, due to abolition of vasomotor reflexes which normally maintain tonus in the vessels below the level of anesthesia The splanchnic vessels and those of the lower extremities may

oxygen saturation and an elevated arterial carbon dioxide content Moreover, opiates markedly increase the sensitivity of some patients to tilting and marked hypotension may follow relatively minor changes in position In contrast, barbiturates do not have nearly so marked an effect upon respiration, and we now use them routinely Atropine or scopolamine is used to reduce the volume of salivation and tracheobronchial secretions, and to diminish the incidence and force of certain cardiac and bronchial reflexes

Laryngospasm One of the most trying problems (in part, because it is so serious) is that of laryngospasm The hazard here is that sufficient hypoxia or hypercapnia will develop seriously to depress the brain and heart The condition rarely results in cardiac arrest, but it does often lead to the postponement of surgery if successful intubation cannot be achieved

The spasm may be managed in several ways Perhaps the most generally satisfactory way is that of using a muscle relaxant such as succinyl choline to relax the spasm, while maintaining the best ventilation possible by compressing the gas bag As soon as the drug has produced relaxation the patient is quickly intubated and then manual respiration is continued until the effect of the relaxing agent has gone and the patient can breathe on his own

An alternative to the use of a relaxing agent is to decrease the concentration of the irritating anesthetic agent in the gas mixture until the spasm has subsided, the concentration is then again increased, perhaps more gradually, with the hope that cord spasm will not recur In the hands of the facile, the use of the muscle relaxant is more expeditious and is safe

Of course, if laryngospasm can be managed in no other way, one can always do a tracheostomy This is rarely required

Intubation In the writer's opinion, few periods of apnea cause less concern to many surgeons and anesthetists than does that associated with the insertion of the endotracheal tube And yet, there is no reason to believe that asphyxia from this cause is any less deleterious than is, for example, that secondary to tracheal obstruction by foreign body or laryngospasm To be sure, the anesthetist should have hyperventilated the patient prior to removal of the face mask, to increase the safe period of apnea due to the effect of the muscle relaxant However, this is not always done,

Overdosage may cause serious reactions and even fatalities, as may topical anesthesia. Absorption through mucous membranes is quite rapid.

THE PATIENT AND HIS ANESTHESIA

It is important that the patient meet the person who is to give the anesthesia, and this should be done the day before surgery. Many patients have strong prejudices against spinal anesthesia, for example, while others are deeply fearful of going to sleep. When possible, the patient's wishes regarding the type of anesthesia to be employed should be respected, particularly if he is adamant. Reassurance that few patients betray secrets while entering or emerging from general anesthesia is often very helpful in having the individual agree to a general anesthetic. By knowing the patient's emotional structure from having visited him even briefly the day before surgery, the anesthetist can better plan the induction. In addition, usually the anesthetist will want to assess, himself, the physiologic limitations which the patient may have. For once the surgeon has gained confidence in the members of the anesthesia staff he may become less sensitive to lesions which may not interfere with the conduct of the surgery but which may present major problems for the anesthetist. Moreover, inasmuch as the professional anesthesiologist has been accorded and has assumed responsibility for the management of the anesthesia, he has a moral and perhaps legal responsibility for the safety of the patient while he is under anesthesia.

SOME HAZARDS DURING AND FOLLOWING ANESTHESIA

Preliminary Steps (Through Intubation)

For the surgeon, perhaps the safety factors generally to be employed in the safe conduct of anesthesia can best be emphasized by discussing the hazards involved.

Preanesthetic Medication. The use of a sedative the evening prior to surgery and again the morning of surgery serves a very useful purpose. It enables the individual to sleep and thus to approach the operation in an optimal state. However, the particular sedative used is quite important. Opiates are not required when the patient is not in pain (few are) and these agents can markedly depress respiration. In fact, when opiates are used for preanesthetic medication, the patient frequently exhibits a diminished arterial

oxygen saturation and an elevated arterial carbon dioxide content Moreover, opiates markedly increase the sensitivity of some patients to tilting and marked hypotension may follow relatively minor changes in position In contrast, barbiturates do not have nearly so marked an effect upon respiration and we now use them routinely Atropine or scopolamine is used to reduce the volume of salivation and tracheobronchial secretions, and to diminish the incidence and force of certain cardiac and bronchial reflexes

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and it may be almost a minute or more before the lungs are again being ventilated through the endotracheal tube (We invite the reader to pause here and, looking at his watch, hold his breath for as long as he can Is it safe to allow the unconscious patient to be apneic longer?) If the tube has not been inserted satisfactorily by the end of 60 seconds, the face mask should be reapplied and the lungs again hyperventilated before further efforts at intubation are made

In addition to delay at intubation, the tube may be improperly inserted (1) It may be kinked in the pharynx, a circumstance which in our experience eventuated in a cardiac arrest that could have proved fatal, (2) the tube may be inserted too far and thus lie in a main bronchus instead of in the trachea, (3) the inflated balloon or cuff may partially or totally occlude the tip of the catheter, (4) the tube may become plugged with mucus or, in one child, with Lipiodol introduced for bronchograms, (5) the insertion of the tube may be so traumatic as to produce postoperative laryngeal swelling

Extubation has been reported to result in cardiac arrest in the occasional patient, but we have never encountered this particular circumstance ourselves

Problems During Later Anesthesia

Pulmonary Ventilation Complications which develop during anesthesia usually manifest themselves sooner or later in arterial hypotension, and certain of these were presented previously (p 36) However the absolute necessity for adequate pulmonary ventilation must be fully appreciated If the blood is not oxygenated and carbon dioxide is not removed, either hypoxia or hypercapnia (respiratory acidosis) may result in cardiac arrest

Pulmonary ventilatory problems may arise due to (1) inadequate "gas bag" assistance of a patient whose own respiratory efforts are inefficient, (2) an obstructed airway from any cause, (3) pulmonary edema, (4) bronchospasm (5) pleural effusion or marked elevation of the diaphragm, (6) emphysema and (7) numerous other defects These problems must be anticipated and prevented or dealt with when they arise

Hypoxia Only by monitoring the arterial oxygen saturation following heavy preanesthetic sedation (especially with opiates), or

during a prolonged effort at endotracheal intubation in the apneic patient or at intervals throughout the operation, can both the surgeon and the anesthesiologist gain an abiding personal awareness of the incidence of hypoxia to which patients may be exposed Unfortunately, if it is abnormal the arterial oxygen saturation is almost always *below* the optimum (It can be increased only slightly above the usual 95 to 100 per cent saturation)

Effective ventilation is the most important means of preventing hypoxia if such complications as anemia, oligemic shock, defective diffusion and failure to fill the gas bag with oxygen (one death we knew of) are excluded

Hypercapnia (Retained CO_2 Respiratory Acidosis) Again the retention of carbon dioxide during inhalation anesthesia is usually the result of inadequate pulmonary ventilation, but it may also be due to an exhausted or otherwise ineffective soda lime cannister, to emphysema or to the use of cyclopropane with a high oxygen concentration in the gas mixture rendering adequate oxygenation possible with less than optimal gas exchange to remove CO_2 (again a ventilatory problem)

Excessive Dosage Although a major risk of excessive dosage with the anesthetic agent is defective ventilation due to respiratory depression, death can result from specific effects of the drug even in the presence of vigorous pulmonary ventilation by artificial means

It is far preferable to "carry" most patients on the "light side" than to risk excessive dosage This is true even for the anesthetist of wide and long experience and it is especially true for the less experienced person We have rarely known of a cardiac arrest in an adequately ventilated "normal patient who was being carried in light surgical (third plane of third stage) anesthesia but we have known of many that occurred during very deep anesthesia

In general, the patient whose anesthesia is properly managed will react shortly after the anesthetic has been terminated This is facilitated by deliberate hyperventilation as the skin sutures are being placed If it is found that most patients are requiring hours to react following the general anesthetic, one must suspect that the anesthetist in question is carrying the patients "too deep "

There are, of course, many practical advantages in having the

patient awake promptly at the close of the operation (1) The surgeon knows that the patient is "all right," (2) he is far less apt to have respiratory complications due to defective ventilation while comatose, (3) the sooner the individual is in touch with his surroundings the sooner he can assist in looking after himself, (4) complications that develop in the recovery ward are more likely to be picked up promptly (pneumothorax, respiratory obstruction, hemothorax, shock etc) in a patient who has been previously alert and not completely comatose there is a greater change for the nurses to observe and, furthermore, the patient can often call attention to his distress

Complications which may occur in the recovery room are considered further elsewhere (p 36)

Hypotension During Anesthesia The commonest cause of significant hypotension during general anesthesia is blood loss or preexisting blood volume deficit Other than this, however, changing the position of the patient, excessive positive pressure ventilation hypoxia, hypercapnia, excessive dosage, compression of the inferior vena cava and noxious reflexes are frequent offenders A transfusion reaction may occasionally produce hypotension as may numerous other incidental complications such as pulmonary embolus The mere injection of a local anesthetic may occasionally give rise to hypotensive episodes (allergic reaction, excessive dosage, skin reflexes) and, of course spinal anesthesia may produce a fall in blood pressure by abolishing sympathetic vasoconstrictor tone to the splanchnic area and to the vessels of the lower extremities

Vomiting with Pulmonary Aspiration The surgeon who insists that the anesthetist begin a general anesthetic without waiting for the stomach to become empty or emptying it by gastric lavage has not (yet) had a cardiac arrest or fatality due to plugging of the trachea and larger bronchi with food particles We once insisted on beginning the anesthesia in a child of 6 years whose mother stated that he had not eaten a thing for 5 hours The anesthesiologist, who had a general policy of waiting a minimum of three hours following hospitalization with children who had "not eaten a thing" for hours reluctantly agreed to proceed However, no sooner had the mask been securely buckled than the child vomited an astonishing volume of lumpy food particles, and only by the most vigorous catheter suctioning and bronchoscopy were we able to

clear the major air passages and prevent cardiac arrest from asphyxia.

A second source of spillage into the lungs during anesthesia is that of a large abscess or tuberculous cavity or the flow of pooled purulent secretions from bronchiectatic areas. Brisk pulmonary hemorrhage presents a similar problem.

Reaction to Local Anesthetics. Management. Most surgeons who use Pontocain and other local or topical agents for bronchoscopy, for example, will eventually encounter a mild to severe reaction. This may begin with an excitement stage that terminates in coma. Thus it is important to use prophylactic sedation. If a reaction develops, pulmonary ventilation should be maintained artificially if necessary, and convulsions controlled with intravenous Pentothal. Since an allergic element may exist, epinephrine should be available for injection. Aminophylline given intravenously may assist in relieving bronchospasm which, if severe, may render effective pulmonary ventilation extremely difficult to achieve.

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ress a litter cannot be found an orderly cannot be located and the single floor nurse cannot leave or any number of other equally exasperating reasons However if the message to give the preanesthetic medication and prepare to send the patient to surgery is given early enough, and then followed up by further calls by the operating room clerk the patient can usually be got to surgery without inordinate delay A critical factor in moving a large volume of cases through surgery is that of not permitting operating rooms to remain idle during the working day The efficient use of the facilities demands intelligent planning and continuous monitoring of all phases of administrative activity

THE OPERATION

Once the patient has entered the operating suite the induction of anesthesia should be started just as soon as he has actually seen the surgeon that he expects to operate upon him The appropriate x-rays should be on hand and selected ones should be placed on the view-boxes in the operating room The intern or a resident should remain nearby during induction of the anesthesia, in case help is needed, for example, thoracotomy may be required for cardiac arrest Moreover, the positioning of the patient must be decided largely by the surgical team, and some member of the team should be available to assist with this

All will meanwhile be alert to the hazard of operating on the wrong hemithorax, leg or inguinal region The chest films should be doubly checked against the identity of the patient, wrapped legs should be unwrapped if there exists the slightest doubt as to which leg is to be amputated, and in infants the absence of a detectable hernia after induction requires that the recorded physical examinations be accurate as to the side on which the physician and the mother saw the bulge preoperatively

The members of the surgical team should themselves be prompt, scrubbed and ready to prep and drape the patient and make the incision just as soon as the anesthesiologist states that all is in readiness Tardiness of individual members of the team delays the various preparations, it annoys the surgeon and it leaves all attendants (and visiting physicians) with a poor impression of the entire surgical service

The patient should not be unnecessarily exposed, but the prep

22 *The Trip to Surgery and the Recovery Room*

DESPITE DAYS of preparation for an operation, specific omissions during the twenty-four hours prior to surgery and immediately following the actual operation can range from embarrassing to hazardous, to disastrous. Therefore let us review some of the problems which may arise from the time the patient leaves his room until he has returned.

GETTING THE PATIENT TO SURGERY: CAUSES OF DELAY

The operation itself is made possible through execution of the preoperative orders written the previous afternoon or evening. (1) The required laboratory data must be on the chart. (2) If patient has eaten solid food since midnight, the danger of vomiting with aspiration during the induction of anesthesia is too great and operation must be postponed. (3) If an adequate amount of compatible blood has not been secured the operation cannot be done. (4) Evacuation of the bladder before the patient goes to the operating room is important when pelvic procedures are to be performed. (5) The relatives will usually have questions and apprehensions that must be answered and allayed. (6) The referring physician should be informed of the scheduled time for operation in the event he wishes to attend. (7) The site of the anticipated incision should have been shaved. (8) If a cut-down is required it may be done on the ward, especially in infants. (9) The preanesthetic medication should be called for in time to avoid unnecessary delay of the anesthesia induction once the patient has arrived in the operating suite.

Unquestionably one of the most annoying sources of delay is that which occurs between the time the nurses on the floor are informed by telephone to send the patient on a litter (or in bed) to surgery and the time when he actually arrives. The delay may be because the preanesthetic medication has not been given, the laboratory work has not been reported, a perhaps unnecessary enema is in prog-



Fig 45—The value of the postanesthetic observation ward cannot be fully appreciated until one has had first hand experience with this facility It affords expert nursing care during the most critical phase of the postoperative period

Table 28—*The Recovery Room A Check List*

1 Blood pressure apparatus and thermometers for both oral and rectal use
2 Oxygen therapy facilities
3 Laryngoscope portable bronchoscope and several types and sizes of airways and endotracheal tubes
4 Kreiselman resuscitator
5 Tracheostomy tray
6 Closed thoracostomy tray (including scalpel with which to make a small skin incision trocar and catheter which will fit inside the trocar)
7 Cut down tray
8 Blood pumping set for rapid transfusion
9 Suction (preferably from wall)
10 Syringes and needles of many sizes sterile for immediate use
11 Drugs likely to be needed for analgesia sedation or for various emergencies
12 Nurses who are well trained

appointed member of the operating team should leave to talk with, or at least send word to, the patient s family Failure to do this will result in unnecessary worry on their part as they continue to wait for news and many relatives are understandably slow to forgive this form of inconsiderate neglect

During the hours that the patient remains in the recovery room it is well for a member of the operating team to drop in from time to time to survey his general status and to check the vital signs, urine output, blood in the drainage bottle etc While the nurses will

should extend safely beyond the outermost limit that the incision (which often has later to be extended) might reach

The *decorum* practiced by the personnel during the operation varies enormously from clinic to clinic While absolute silence is not necessary except under delicate circumstances, in our opinion, the comments should be directed with the general objective of disseminating information relative to the diagnosis, pathology, technical handling of the lesion found, and the prognosis The time actually devoted to technical operating should be used with an earnest pur pose and always with the best interests of the patient, not of someone else, kept uppermost The surgeon has a right to expect of his team their best efforts And, conversely, the team has a right to expect of the surgeon that he will require them to act and perform to the best of their abilities Nothing less should be expected of either During the course of the operation the assistants will constantly be alert to assist quickly in any way possible (Note to residents The assistant who anticipates and assists the chief most effectively is the one who will do the most independent operating in the future)

As the skin is being closed the patient is usually allowed to wake up During this period particular care is exercised to aspirate tracheal secretions with a catheter, both before and after the endotracheal tube has been removed, or to prevent brachial plexus damage by overstretching when an arm dangles limply The blood pressure may fall as the patient is turned on his back from a lateral position, and the vital signs should always be rechecked before the patient is moved from the operating room

THE RECOVERY WARD

The *postoperative orders* are best written while the patient is still in the operating room First this allows the nurses manning the recovery ward (FIG 48) to begin any important measures immediately (TABLE 28) Second in addition to the usual routine orders the intern may need to write special orders (as following cardiotomy) *about which he may wish to ask the resident or the* surgeon These questions are more readily cleared up expeditiously when all are present All tubes should be securely fixed to the dress ings and properly connected to drainage bottles or clamped during the trip to the recovery room As soon as the patient has been safely transported to the recovery room and the vital signs checked some

23 *Some Common Postoperative Problems*

THERE ARE CERTAIN complications which may occur after almost any major operation. Some of these have been mentioned previously, but most of them will now be taken up with special emphasis. The following will be considered:

(1) Coma
(2) Shock
(3) Dyspnea and/or cyanosis
(4) Anuria or oliguria
(5) Pain
(6) Fever
(7) Nausea and vomiting
(8) Paralytic ileus with distention
(9) Fecal impaction
(10) Electrolyte imbalance
(11) Hiccups
(12) Psychosis
(13) Allergic reactions
(14) Phlebitis

POSTOPERATIVE COMA

With a few exceptions postoperative coma may be due to any of the causes which produce this condition under other circumstances. However, with adequate preoperative screening such states as diabetes mellitus, uremia, electrolyte imbalance, and brain injury or tumor should have been excluded or treated. Thus we shall here direct our attention to states of coma which are met postoperatively in previously "healthy" subjects. Among the more prominent etiologic factors in postoperative coma are:

(1) Excessive dosage of anesthetic agent
(2) Brain damage during anesthesia (hypoxia or hypercapnia with acidosis)
(3) Shock from any cause (p 36)
(4) Cerebral hemorrhage or thrombosis
(5) Overwhelming septicemia
(6) Fluid imbalance
  (a) Overhydration with water intoxication
  (b) Underhydration with increased osmolarity
  (c) Low sodium syndrome
  (d) Hypopotassemia
(7) Hypoglycemia (due to liver failure?)

The treatment of these various states producing coma readily follows once the diagnosis has been made. Of these, hypoxia with brain damage (and cerebral edema) and shock constitute the two

have kept a close watch, the more trained the observer the more he will see The physician is often able to detect warning signs of impending disaster before a nurse does By this time, too, the patient himself often wants to know what was found and the reappearance of a familiar face is generally reassuring Perhaps the morphine dosage needs to be increased or decreased The postoperative orders can be reviewed and perhaps additional ones added that now appear indicated

BACK IN HIS ROOM

Finally the patient is returned to his room in bed By this time he should be awake and his blood pressure stable The tubes are again connected to suction or to simple drainage, as required The intravenous infusion is checked The vital signs are again checked Perhaps the chest is auscultated for estimating pulmonary ventilation The family is reassured The attending nurses are instructed regarding any special features of the case And the postoperative period is well under way

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(7) Pulmonary embolism
(8) Pain and/or apprehension
(9) Reduced lung volume (pulmonary resection, elevated diaphragm, intrapleural air or fluid)
(10) Acidosis (diabetic or renal)
(11) Shock from any cause
(12) Muscular weakness (e.g., myasthenia gravis)
(13) Increased metabolic requirements (e.g., fever, thyrotoxicosis)
(14) Emphysema with respiratory acidosis

When it is observed that a patient is dyspneic, a thorough examination is in order to discover the cause and institute treatment promptly, for mild respiratory distress may abruptly be followed by fatal asphyxiation. The first steps to be taken are to make certain that the airway is patent and that the lung volume has not been reduced (auscultation and chest film). Hypotension is treated by blood transfusion unless the respiratory problem appears to be the cause of the shock. When it has been established that the blood pressure and pulmonary ventilation are satisfactory, other causes can be sought. If the blood pressure and rectal temperature are normal and pulmonary ventilation appears to be adequate by physical examination and chest x-ray, other possible explanations must be considered. A normal "CO_2" renders acidosis unlikely. If there is no reason to suspect heart failure and no other obvious cause is apparent, an early pulmonary infarction may exist, which may not be visualized on the chest film until hemoptysis, a pleural friction rub, and pain are well established.

In general, then, the management of postoperative respiratory distress will depend on identification of the cause. *Respiratory obstruction* is relieved by tracheostomy if necessary. *Pneumonitis* is treated with antibiotics and if indicated oxygen therapy. *Atelectasis* is managed with nasotracheal catheter suction, frequent coughing and, upon occasion, bronchoscopy. *Pulmonary edema* is treated with positive pressure oxygen breathing, digitalization (also used in heart failure *per se*), elevation of the trunk, aminophylline, and venous tourniquets. *Shock* and *acidosis* are treated according to the cause.

Pulmonary Embolism. This complication deserves separate and specific attention if for no other reason than that its physiologic effects are still obscure. It is now generally recognized that pulmonary embolism has many faces. For many years most of us thought of the condition as one that came with dramatic suddenness, usu-

most common conditions Immediate artificial hypothermia continued until the patient awakens (often days later) has been used successfully in the management of cerebral edema due to hypoxia, perhaps secondary to cardiac arrest Shock is treated according to the needs of the moment (blood transfusion? hydrocortisone? antibiotics?)

POSTOPERATIVE SHOCK

The causes of preoperative, operative and postoperative shock were listed previously (p 36) This is one of the commonest postoperative complications of major surgery, and it is usually due to hypovolemia When there is doubt as to the etiology (which may consist of concealed intra abdominal hemorrhage), give a diagnostic blood transfusion rapidly (500 cc) If this maneuver causes a significant rise in the blood pressure, even if temporary, suspect a diminished blood volume If repeated transfusion fails to produce a stable blood pressure at a normal level, consider the possibility of continuing hemorrhage or "irreversible" shock, perhaps due to gangrenous bowel Brain damage or myocardial ischemia may also result in shock, despite a normal blood volume Therefore, clinical evaluation, chest x ray, Hgb and Hct levels, ECG and plasma and blood chemistry values are all of assistance, on different occasions, in the diagnosis of shock which may or may not be producing coma Intravenous hydrocortisone and norepinephrine are used when adequate pulmonary ventilation, nasal oxygen and blood transfusion fail to elevate the blood pressure

POSTOPERATIVE DYSPNEA AND/OR CYANOSIS

It is a fact that a great many of the more serious postoperative complications give early warning by causing changes in *respiration, pulse rate and blood pressure* The causes of actual shock were discussed previously and we shall now review here in somewhat further detail some conditions which result particularly in objective rapid or labored respiratory effort and in subjective dyspnea Some changes associated with surgery which alter respiration are

(1) Aspiration pneumonitis
(2) Irritant effect of anesthetic agent (reduced pulmonary compliance)
(3) Pulmonary edema (various causes)
(4) Heart failure
(5) Respiratory obstruction (tracheal or bronchial)
(6) Atelectasis

(d) Oligemic shock following surgery
(e) Dehydration (not usually present)
(f) Heart failure
(g) Liver failure
(h) Adrenocortical failure

In general, the diagnosis in each instance listed suggests also the therapy. Many patients secrete a relatively small volume of urine during the first 24 hours postoperatively, but then more than make up the deficiency during the next two days. In the absence of truly severe oliguria or actual anuria, one need not be unduly concerned until 24 hours have elapsed. If by then the patient is still secreting very little urine and he is not obviously dehydrated, the possibility of acute renal shutdown must be genuinely entertained and appropriate measures instituted; daily fluid intake is limited to 800 cc plus measured losses. However, measured losses do not take into account the excessive sweating which may occur. If the patient can be weighed daily, all the better, and he is allowed to lose a pound each day. Carbohydrate and fat are administered intravenously and by mouth as opportunity permits, to minimize protein catabolism and the liberation of potassium ion; yet, since fluid intake must be severely restricted, the caloric intake that can be achieved is usually sharply limited. Some patients will gradually increase their urine output and eventually recover. Others may recover if effective artificial dialysis can be performed, as needed for hyperpotassemia and coma, to permit them to survive long enough for renal tubular regeneration to occur. However, the mortality in acute renal shutdown exceeds 50 per cent in most series treated, even where extracorporeal dialysis is available.

Where *obstructive uropathy* exists, a catheter can usually be passed and, if not, a suprapubic cystostomy can be performed. In most patients the catheter can be removed without the necessity of prostatectomy, once the patient is ambulatory. However, some older men may continue unable to void spontaneously until either a transurethral or suprapubic prostatectomy has been carried out. When a catheter must be worn for more than a day or so, it should be changed regularly, at least twice a week. Moreover, it is advisable to place such a patient on low dosage of Gantrisin (1 Gm b.i.d.) during the period of catheter drainage. The management of ureteral and bladder injuries was briefly considered in connection with colon resection (p. 172).

ally in the early postoperative period, produced collapse, and often terminated fatally However, we now know that such dramatic and rapidly fatal episodes comprise only about one third of the total instances of pulmonary embolism, and that pulmonary embolism is about as common in medical as in surgical patients In fact, multiple small emboli may bombard the smaller pulmonary arteries over a period of months gradually producing such a reduction in the pulmonary vascular bed that pulmonary hypertension and cor pulmonale may result in right heart failure, with few if any painful episodes of pleuritic pain and hemoptysis And, finally, there is the intermediate group in which repeated episodes of obvious infarction are associated with changes in the chest film which gradually clear if the particular episode in question does not prove fatal Such a patient may exhibit a yellowish hue and the serum bilirubin level may be elevated An infarcted area may "cavitate" and resemble a lung abscess on the x-ray film

The source of the emboli is often as obscure as is the mechanism by which embolic occlusion of a smaller branch of the right or left pulmonary artery can produce shock and death Few now believe that "virtually all" emboli arise in the deep calf veins, though some clots do arise in these vessels We now ligate the superficial femoral veins only when there is definite evidence that the source of repeated embolization is definitely distal to this level Vena caval ligation is only very occasionally indicated, for the sequalae can be formidable Anticoagulant therapy (p 256) is widely used in the treatment of phlebothrombosis with or without pulmonary embolism

POSTOPERATIVE ANURIA OR OLIGURIA

Failure to produce "enough" urine in the early postoperative period may be due to any of a wide variety of factors

(1) *Urinary Tract Obstruction or Injury*
- (a) Prostatic hypertrophy
- (b) Urethral stricture
- (c) Inability to void due to neuromuscular fault (temporary)
- (d) Ligation of ureters (unilateral error fairly common bilateral rare)
- (e) Defect (traumatic) in bladder

(2) *True Reduction in Urine Formation*
- (a) Reaction to injury
- (b) Renal damage (lower nephron nephrosis) due to hypotension during surgery (shock) or to transfusion reaction Both result in renal hypoxia
- (c) Previous renal damage

lism pleurisy or myocardial infarction among others Thus pain not arising in the incision must be diagnosed as to etiology and then treated appropriately However the patient who has had a major operation is apt to have many minor "aches and pains which require no exhaustive diagnostic investigation only observation and symptomatic therapy being needed When laboratory studies are required they often include an ECG an x-ray of the chest and the abdomen serum amylase level urine culture to exclude infection and total white cell count and hematocrit values Finally, evacuation of a distended stomach may provide relief of pain in many patients

Chest pain following operations that do not involve the chest is often a warning of a serious complication While only a neuromuscular or arthritic phenomenon may be involved the alert house officer will think of the possibility of coronary occlusion pneumonitis or pulmonary embolism The electrocardiogram and chest film are helpful in most instances in identifying or excluding these possibilities Pain in the right upper quadrant may be due to diaphragmatic irritation by pneumonitis or lung infarct Such pain following a thoracotomy can be due to acute intercurrent cholecystitis

One great value of a chronologic chart of the daily temperature pulse, and respiratory values is that it allows the physician to see at a glance whether the trends of these values are increasing remaining the same or decreasing As a rule all three tend to vary in the same direction, since an elevated metabolism due to pyrexia requires a greater oxygen intake and cardiac output

POSTOPERATIVE FEVER

After the initial mild febrile stress response to the operation itself has subsided, usually within from 24 to 96 hours many patients exhibit essentially normal "vital signs —the oral or rectal *temperature, pulse rate, respiratory rate* and *blood pressure* Thus when the fever is excessive for a mere stress response to surgery, or when fever develops after a postoperative afebrile interval of several days, some postoperative complication must be sought The more common causes of postoperative fever are

Early in Postoperative Period

(1) Stress response to injury
(2) Pulmonary atelectasis and/or pneumonitis

POSTOPERATIVE PAIN

A number of points regarding postoperative pain are pertinent here First patients vary enormously both as to the amount of pain they feel and as to the amount of pain they elect to tolerate before *requesting an analgesic Many wounds cause little pain after the* first 48 hours unless the patient moves or when the part must move as in respiration, if the wound is unduly painful it should be inspected

It is usually preferable to write the order for morphine or meperidine q 3 hours or 4 hours "p r n ", rather than "straight " For excessive opiate dosage can so depress respiration as to produce shock from hypoxia This is a special hazard in elderly patients and in those who have had pulmonary resection, where the cough reflex is so important in preventing atelectasis of varying degrees For the usual adult of average size we recommend from 8 to 10 mg of morphine sulfate or from 50 to 75 mg of meperidine every 4 hours, when necessary for actual pain When only sedation is required, rather than analgesia the use of a barbiturate or even chlorpromazine is preferred to an opiate, the former drugs do not have the respiratory depressant effect to the same degree as do morphine and meperidine Thus, while the "on call" order may result in some pain to the patient when the nurses are busy and he cannot get immediate attention, he will at the same time not be subjected to the hazards of hypoxia and atelectasis that might result from the prescription of morphine every 4 hours "straight " Actually, within 48 hours following surgery or as soon as oral intake has been resumed, we prescribe codeine sulfate (0 03 Gm) and aspirin (0 6 Gm) for the relief of pain Late pain and tenderness in the wound suggest hematoma, infection or impending separation

Of course by no means all *postoperative pain need be incisional* pain If a cast has been applied and the patient complains of pain beneath it the cast should be removed if the slightest question of circular (ischemic) compression or of point pressure exists, else, either a foot or a hand may become gangrenous, or the soft tissue (skin and perhaps tendons) beneath a pressure area may slough Of such complications are lawsuits made

Nonincisional abdominal pain may be due to intestinal distention from mechanical or paralytic ileus peritonitis, cholecystitis pancreatitis, ischemia of bowel bladder distention, pulmonary embo-

gery If cardiac arrest occurred or if there was marked hypotension for a time because of blood loss defective respiratory function or excessive dosage of the anesthetic agent the temperature curve may later offer important prognostic data Although the temperature may be normal in the immediate postoperative period it will frequently become elevated later that night or the next day often to very high levels if serious brain damage or cerebral edema has been produced This hyperpyrexia all too often precedes a gradual death Of course, most such patients have never fully reacted from the anesthesia, which in itself is a very serious sign and is still another reason why one wants the patient to react promptly at the end of the operation

There is evidence that if these patients are promptly rendered hypothermic and maintained at 32°C (R) until they awaken some will survive without brain damage

Venous Thrombosis and Thrombophlebitis Certainly one of the prominent sources of mild to moderate fever in the early postoperative period is venous thrombosis with or without active bacterial involvement The patient may exhibit an "unexplained fever within 48 hours of surgery, usually associated with an increased pulse rate However, examination of the legs may reveal mild moderate or even severe tenderness or swelling of one member due to deep venous occlusion—or of both if vena caval occlusion has occurred which is not particularly rare

The two most serious hazards of deep vein occlusion are pulmonary embolism and late postphlebitic sequelae which include incapacitating pain, swelling and ulceration of the lower leg

The *treatment* of acute bland venous thrombosis is a matter of greater urgency than is the treatment of well developed thrombophlebitis, since it is not often that pulmonary emboli arise from venous thromboses that have been rendered firmly adherent by the intense inflammation that may be associated with venous infection

While it is not truly established that any specific measures effectively reduce the incidence of pulmonary embolism in most instances, some reasonably consistent plan of management is desirable and the following routine is widely employed The patient is placed at bed rest and anticoagulant therapy is begun If marked swelling is present, the affected leg or legs are elevated The use of elastic bandages, wrapped from the toes upward is often practiced, but one feels that this procedure may carry certain hazards For in-

(3) Brain damage due to hypoxia during surgery
(4) Venous thrombosis and thrombophlebitis
(5) Acute adrenocortical failure with crisis

Later in Postoperative Period

(6) Urinary tract infections
(7) Wound infections
(8) Intrapleural or intraperitoneal suppuration
(9) Staphylococcal enterocolitis

Other Causes in Special Circumstances

(10) Damage to heat regulating center at craniotomy
(11) Post thyroidectomy fever with or without crisis
(12) Fever due to necrotic tissue
(13) Various medical causes such as heat stroke malarial relapse allergy to drugs malingering (placing thermometer on radiator) intercurrent systemic illnesses such as influenza etc

Stress Response to Injury Pyrexia from this cause should be mild, and is doubtless due in part to the calorigenic effect of epinephrine-like substances liberated as well as to a reduced rate of heat elimination mediated through the hypothalamus An increased rate of general body metabolism, due to either hormonal stimuli or the physicochemical effects of retained body heat, may also be a factor in further increasing body temperature

Pulmonary Atelectasis and/or Pneumonitis The appearance of excessive fever (greater than 1 to 2°F) in the early postoperative period is very likely to be caused by pulmonary complications These can be detected on physical examination and further confirmed and delineated with a chest x-ray Usually not only the temperature but also the pulse rate respiratory rate and leukocyte count are increased *Treatment* may require nothing more than deep breathing and effective coughing thoroughly stimulated by nasotracheal catheter suction Bronchoscopy does not often accomplish more than does vigorous suction of the trachea and each main-stem bronchus Of course since all too often the atelectasis is caused by or associated with pneumonitis perhaps the result of aspiration during the operative or immediate recovery period antibiotic therapy is also indicated Steam inhalations from a croup kettle" may loosen thick and tenacious bronchial secretions and facilitate their removal by coughing or by nasotracheal catheter suction Oxygen therapy may be used if needed and early ambulation will diminish the risk of atelectasis in other areas of the lungs usually at the bases

Brain Damage Due to Hypoxia During Surgery This complication can usually be anticipated from the train of events during sur-

initially A major diagnostic problem often consists of deciding whether minimal calf tenderness represents venous disease or not If in doubt, we wait 24 hours before embarking on the 10 day course of anticoagulant therapy

Acute Adrenocortical Failure This condition was discussed in connection with the management of both postoperative shock (pp 38 and 212) and adrenalectomy

Urinary Tract Infections Bacteria may be present in the urinary tract but others are frequently introduced by the promiscuous ("routine) use of catheters introduced before at or immediately following surgery For example it has been shown that bladder urine obtained by needle aspiration at laparotomy may be sterile on culture, whereas "sterile catheterization of the same patient results in a "positive" urine culture Obviously the bacteria were in the urethra, not the bladder

The patient should be urged and given every opportunity to void spontaneously, before catheterization is resorted to Nevertheless to allow prolonged overdistention of the bladder is as undesirable as is the unnecessary use of the catheter Prolonged stasis in the bladder may permit an enormous multiplication of bacteria and then, if overdistention results in ureteral back pressure pyelonephritis may develop Moreover several days of severe overdistention with "incontinence of overflow ' may so disturb the neuromuscular function of the organ that weeks of continuous or intermittent catheter drainage may be required again increasing the risk of urinary tract infection To be sure with the institution of adequate catheter drainage and decompression the bladder tone usually returns to normal, in time, but meanwhile otherwise successful surgery may have been thoroughly discredited by the urinary tract disability

Nevertheless, a great many urinary tract infections develop in the absence of calculi catheterization, urinary retention or urethral stricture

The *treatment* of urinary tract infections consists chiefly of making certain that free bladder emptying is present and the use of antibacterial drugs In the absence of urine cultures that reveal a predominant organism (usually gram-negative) with specific antibiotic sensitivities Gantrisin (1 Gm q i d for 7 to 10 days) affords a frequently effective compound Penicillin may be used separately or in conjunction with Gantrisin, but the former is not particularly ef-

stance, while such wrapping may and often does reduce the swelling could it not have the effect of massaging the venous thrombus to a more central location? Certainly the promiscuous use of such bandages, *at much cumulative expense, has not materially reduced the* incidence and severity of venous disease and pulmonary embolism *in bed patients. They are valuable once the patient is ambulatory*, to reduce swelling.

The anticoagulant therapy usually consists of an intramuscular long-acting heparin compound (50 mg./6 hours for 48 hours) and an oral dicumarol compound (300 mg. first day, 200 mg. second day, 100 mg. third day). The effect of heparin begins very promptly, and maintains a prolonged clotting time until the specific hepatotoxic effect of dicumarol in reducing liver prothrombin synthesis has resulted in a lowering of the prothrombin time to ranges of from 20 to 40 per cent of normal. Of course, a control prothrombin time should be secured, and thereafter the dosage adjusted to maintain the prothrombin time at the desired level. There are usually no ill effects from the dosage of heparin given above, but to be safe one may do repeated clotting times. Even so however there may be considerable fluctuation in the clotting time over the 6 hours following each dose, for absorption from even the compounds designed to permit the release of heparin at a uniform rate is erratic. There is a trend toward the use of heparin exclusively, and many now give 100 mg. intravenously in one slug every 6 hours. We believe this dosage may be one which will produce complications from "spontaneous" hemorrhage in an unnecessarily large (though still small) percentage of patients. Time will tell.

At the first sign of "spontaneous" bleeding the anticoagulant therapy should be stopped. The effect of heparin can be promptly counteracted with protamine sulfate, milligram for milligram. The effect of dicumarol can be counteracted by the injection of liberal and repeated doses (*e.g.* 500 mg.) of vitamin K_1 oxide, preferably at a slow drip intravenously. Its action in increasing the prothrombin level is less prompt and less certain than is the action of protamine in returning the clotting time to normal after heparin therapy.

Once anticoagulant therapy has been started it is usually continued for from 10 to 14 days assuming that adequate evidence of phlebothrombosis with or without pulmonary embolism was present

collection of pus is dissecting a path between the layers of the abdominal wall

Antibiotic therapy has long been used prophylactically, but wound infections still are frequent, meanwhile many bacteria have been rendered antibiotic-resistant by such indiscriminate use of these agents Moreover, dependence on this prophylactic therapy has too often resulted in "sloppy" aseptic technic in the operating room, allowing clearly avoidable wound contamination to occur Many of us have been derelict at one time or another Fortunately, most surgeons have now come to realize the danger of rendering wide ranges of bacterial flora antibiotic-resistant Rather, most of us have re-evaluated our aseptic technic and renounced prophylactic antibiotic therapy in all except certain thoracic cases and those abdominal cases in which portions of the alimentary tract have been opened at operation In this connection, we feel that thorough irrigation of the thoracic cavity, and, at times, the peritoneal cavity at the close of the operation is useful in removing blood clots and bacterial contaminants

When evidence of wound infection does appear, however, antibiotics are begun If only cellulitis is present and no pus can be secured for culture and the evaluation of bacterial sensitivities, a combination of penicillin (100,000 units) and streptomycin (0 5 Gm) given intramuscularly every 6 hours constitutes satisfactory therapy Of course, as soon as pus (or a positive blood culture) is available, specific sensitivity findings may dictate a change in drug or in drug dosage Fluid aspirated from an area of cellulitis, especially following injection of from 1 to 2 cc of saline may at times permit identification of the causative organism

Complications of antibiotic therapy include the suppression of infection (and fever) until the patient is at home, often staging the ordeal of readmission, allergic phenomena such as skin rashes, urticaria, or fever, and the overgrowth of resistant organisms such as is represented by pseudomembranous staphylococcal enterocolitis

Intrapleural or Intraperitoneal Suppuration Few postoperative complications can be more difficult to diagnose accurately than are intracoelomic pus collections, upon occasion In general, thoracic empyema is far more readily detected than is intraperitoneal suppuration This is because of the greater facility and precision of plain and special roentgen studies of the chest, as well as the rela-

fective against gram-negative bacilli Chloramphenicol may be the preferable drug in many instances

As a rule if the signs of infection (fever, chills, dysuria pyuria, etc) clear promptly, *the above measures suffice and special roentgenography* and cystoscopy are not required If the infection persists or septicemia develops, however, an intensive search should be made for other precipitating urinary tract pathology and for suppurative foci elsewhere in the body Furthermore, the antibiotic sensitivities of the predominant organism or organisms should then be carefully employed in selecting the antibiotic to be used While gram-negative organisms of the coliform type are perhaps *the most* common offenders a wide variety of bacteria, including the staphylococcus, may represent the causative microorganism in the individual patient

Urinary tract infections have increased in clinical importance as other serious and formerly more prevalent infections have been brought under control

Wound Infections Bacterial growth with suppuration in the operative wound was discussed previously (p 55) The wound infection usually does not develop until several days have elapsed, to permit time for multiplication of the bacterial contaminants (usually staphylococci) with surrounding suppuration An exception to this is found in the occasional streptococcal infection, where a fiery-red, erysipeloid edematous lesion extending away from the margins of the wound may produce marked fever within from 24 to 48 hours

The *diagnosis* of wound infection is prompted by the presence of systemic malaise fever and leukocytosis associated with local pain, erythema induration swelling and tenderness at the operative site The wound should not be spontaneously painful after 48 hours in most patients Thus pain and tenderness in a wound even when visible evidence of deep infection has not yet become manifest, *should alert the physician to the probability of infection The application* of moist heat (and the avoidance of indiscriminate blind "probing") will result in visible localization of the infection eventually The incision can then be opened at the proper site, often with a hemostat the pus allowed to escape (relieving the pain) and a suitable drain inserted It has been pointed out that abdominal or wound pain is due to inflammation pressure, tension and ischemia Several or all of these may be present in the wound where a large

collection of pus is dissecting a path between the layers of the abdominal wall

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tively innocuous effects of blind needle aspiration that is nonproductive Thoracic empyema is managed by closed or open drainage (p 117) Thus, whereas the cause of fever following pulmonary resection can often be shown to be very likely due to pulmonary atelectasis, pneumonitis or opacification which on needle aspiration proves to represent empyema, intraperitoneal abscesses all too often are discovered at the autopsy table For this reason, we have more and more adopted a policy of exploratory laparotomy when fever and anorexia continue but no mass can be palpated

The patient with a subdiaphragmatic, pelvic or intraperitoneal abscess may have roentgenologic or physical findings which permit actual localization of the abscess, following which an appropriate incision is made and the abscess drained This generally results in prompt recovery and rehabilitation Naturally, postoperative intra-abdominal abscesses usually follow abdominal operations, although acute cholecystitis with rupture, perforation of a peptic ulcer or acute appendicitis with perforation may occur following even a thoracic procedure On the other hand, the patient may have little or no fever while he is on heavy antibiotic therapy His appetite is poor, he does not regain his strength and vigor at the expected rate, bowel function is not normal and vomiting may occur from time to time, he develops a "chronically ill" appearance and continues to lose weight, in part because he cannot or will not eat, the abdomen presents perhaps an indurated "feel" but no definite masses or specific tenderness is noted often because of small bowel distention Rectal and pelvic examinations are within normal limits, the leaves of the diaphragm move fairly well on inspiration the liver edge is barely palpable, the stomach is displaced, perhaps (but as a result of the gastric resection?), the duodenal loop may be a bit widened (but does this actually represent an abscess of the pancreas?), the barium enema may reveal some questionable downward displacement of the splenic flexure of the colon, but the nephrograms show that the kidneys are not displaced The small bowel pattern is difficult to interpret because of the inordinately prolonged "ileus"

Such a patient is often allowed to drift from week to week, everyone hoping that he will "straighten out And the crux of the problem is that, of course, many such patients do improve and recover without further and hazardous surgery This is why it is so difficult to elect an exploratory laparotomy until the patient may be critically

debilitated and likely to die from the operation or until the patient dies without operation and the "silent" abscess is drained by the pathologist

To conclude, we are now convinced that when the probabilities of an intraperitoneal abscess persist reasonably early exploratory laparotomy constitutes less risk than to delay too long. Such abscesses now constitute a significant cause of surgical mortality. Unfortunately, no "routine" rule for guidance can be offered and each case must be decided on its own merits

Staphylococcal Enterocolitis Contrary to popular belief pseudomembranous enterocolitis *per se* is not a new entity for it was reported a number of years ago following shock due to various conditions However, the relatively specific staphylococcal pseudomembranous enterocolitis that may follow the use of broad spectrum antibiotics in the postoperative period is a relatively new entity The mechanism is believed to consist of a reduction (with antibiotics) of the intestinal flora that is normally present and antagonistic to the antibiotic resistant staphylococci There results an enormous overgrowth of the usually suppressed staphylococci The mucosal and submucosal layers of the involved bowel are so heavily infected that gangrene of these tissues occurs, and mucosal casts or strips may be passed in the stool Meanwhile the patient has become febrile perhaps with chills and an associated shock-like state and an explosive diarrhea may have developed The *treatment* consists of heavy dosage of an antibiotic to which the staphylococcus (resistant to penicillin) will respond This has usually been Erythromycin or Ilotycin Many of these patients have died, but with the early use of proper antibiotics, plus aggressive general supportive treatment, many can be saved

Damage to Heat-Regulating Center at Craniotomy High postoperative fevers are common on neurosurgical services, due to operative interference with the heat-regulating center in the region of the hypothalamus Such fevers often precede a fatal outcome, but every effort should be made to keep the rectal temperature below 105°F Fevers above this level are not long-tolerated Various neurosurgical services use different technics Aspirin is given to combat the fever by its effect in "lowering the thermostat" and in producing sweating Ice water enemas are effective and are time-honored In our hospital however, a portion of the body is placed in cold water, while the re-

mainder is continuously moistened with an ice water-alcohol mixture and electric fans directed across the moistened surfaces to increase the rate of heat loss by vaporization A break in the fever usually represents a favorable prognostic sign More recently, the cooling (hypothermia) blanket has become generally available for the efficient reduction of body temperature, and by this means the cooling process remains under far more effective control

Post-thyroidectomy Fever Febrile reactions of varying degrees, often severe, formerly were frequently observed following thyroidectomy for toxic goiter That such pyrexia is now uncommon attests the better control of hyperthyroidism that is possible with modern antithyroid drugs such as propylthiouracil and tapazole While iodine was adequately effective in preparing the majority of patients for surgery, there were many in whom the thyrotoxicosis was never fully abolished prior to operation, and it was in this group that postoperative fever was usually encountered

The fever which follows thyroidectomy in the previously thyrotoxic patient is probably due to an excess of circulating active thyroid principles, though the precise mechanism is not entirely clear If the fever is severe, the total condition is referred to as thyroid crisis and it is often fatal While it has been reported that intravenous adrenocortical therapy in massive doses is effective in combatting thyroid crisis, we did not find it so in one patient so treated In fact, so grave is well developed thyroid crisis that it is now our policy to operate on no patient whose metabolic rate cannot be brought to the euthyroid level with iodine or other antithyroid medication, however young the individual The possible risks of radioactive iodine are preferable

The febrile reaction following thyroidectomy is treated with intravenous sodium iodide sedation oxygen therapy, cold sponging and digitalis if indicated in addition to the intravenous hydrocortisone

Pyrexia Due to Tissue Necrosis The sloughing of tissue, perhaps in the center of a tumor or due to ischemia of non-neoplastic tissues, often produces fever We recently (1957) encountered this in a patient who had a huge nontoxic nodular goiter Despite antibiotic therapy the fever persisted, and at operation large collections of sterile, thick liquefaction necrosis were evacuated Postoperatively there was no further fever

Various "Medical Causes of Fever In addition to the causes

given one might list heat stroke malarial relapse allergic reactions intercurrent systemic infection such as influenza, elevated ambient temperature (especially with infants and, above all, with prematures), and malingering (the patient may place the thermometer on the radiator) These should be considered when no "surgical" explanation for the fever can be found

POSTOPERATIVE NAUSEA AND VOMITING

Nausea and vomiting are frequently observed following operation If the patient has fully recovered from the anesthetic and no further agent is detected in the expired air, an alimentary problem will usually be found to exist The most common defect is that of acute *gastric retention*, and it is especially likely to occur after upper abdominal procedures such as cholecystectomy However, it may follow thoracotomy or even hemorrhoidectomy (one fatal case) The milder degrees of gastric retention are not serious except in that they precede the very sinister condition termed *acute gastric dilatation* Here the atonic stomach may be enormously dilated and may contain as much as 5 liters of fluid This was the condition found in the patient mentioned above who died following hemorrhoidectomy, of all things He had vomited small amounts repeatedly, but the physicians in charge had not suspected the full scope of the problem in time to correct it

Of course, postoperative nausea and vomiting may be due to a great many other causes, but gastric retention or intestinal dysfunction (mechanical or paralytic ileus) are the most important ones Mechanical bowel obstruction in the postoperative period is usually due to *adhesions which constrict the small bowel, but colon obstruction* due to fecal impaction may occur in elderly patients

The *treatment* of postoperative nausea and vomiting usually consists of *prophylactic measures, nasogastric suction*, and *intravenous fluids* *Dramamine* can be given intramuscularly to combat nausea, and it often does However, there is the risk that by suppressing nausea one may permit gastric distention to continue, even if this distention is a reflex phenomenon secondary to urinary bladder distention

First, the prophylactic measure most important is that of restricting oral intake until the day following a general anesthetic for a major operation This alone will substantially reduce the incidence

of gastric retention and dilatation Nasogastric suction for 24 hours following upper abdominal operations constitutes another effective prophylactic measure *Second*, when the patient begins to vomit—and he may "effortlessly" vomit only small amounts at infrequent intervals—a Levin tube should be passed promptly and the stomach contents aspirated If the volume is large, the tube should be left down for from 24 to 48 hours If the volume is minimal the stomach is irrigated with saline and the tube removed Oral intake should be stopped for the time being Dramamine can then be used with more confidence though bowel pathology or increased intracranial pressure must be kept in the back of one s mind as remote possibilities *Third*, intravenous replacement of water, sodium chloride and potassium must be adequate to replace large fluid losses and thus prevent shock

There are numerous other occasional causes of postoperative nausea and vomiting (if due to morphine, change drug), but those described above will account for this symptomatology in most instances

PARALYTIC ILEUS

Paralytic ileus following surgery usually must be differentiated from mechanical small bowel obstruction (p 157) The mechanisms by which the ileus is produced are largely obscure, and understanding is rendered still more difficult by the wide range of etiologic factors which may produce the condition One expects a degree of ileus in association with any abdominal operation, with or without a degree of peritonitis, but it may occasionally be equally severe following thoracotomy laminectomy septicemia or even secondary to urinary bladder distention or other urinary tract disease

Management of paraylitic ileus consists of both prophylactic and therapeutic measures Prior to surgery one can have passed a nasogastric or long tube to decompress the alimentary tract Manipulation of the bowel is minimized and peritoneal contamination is avoided Meticulous hemostasis and precise ligation of vessels without strangulation of masses of tissue further promote a mild intraperitoneal reaction to the procedure Bladder distention is not permitted to occur

Active therapy of the established condition is often disappointingly ineffective, until the distention has run its course Nevertheless, the following measures often do effect considerable relief (1)

alimentary tube decompression, (2) nothing by mouth, (3) intravenous fluid maintenance (4) sedation as required, (5) a rectal tube, with or without low saline enemas, (6) heating pad or hot water bottle to the abdomen (7) ambulation if permissible, (8) prostigmin, pitressin, or urecholine intramuscularly in the occasional case Needless to say, the condition underlying the ileus is treated vigorously, if known

Paralytic ileus with distention rarely produces such ischemia of the bowel wall as to result in perforation However the condition may continue for long periods, and it can seriously impair pulmonary ventilation, compress the intra-abdominal viscera and large veins, preclude oral intake and inordinately retard convalescence Again, it is the underlying condition often intraperitoneal suppuration, that is the true offender

FECAL IMPACTION

In the patient who has difficulty or undue discomfort in passing small amounts of stool postoperatively, or who has diarrhea or feels that he never really empties the rectum fecal impaction should be suspected The diagnosis is usually made by simple digital examination, but occasionally an impaction in the sigmoid may not be diagnosed without sigmoidoscopy or barium enema (Obstruction of the sigmoid colon was so produced in one elderly lady)

Treatment consists of the instillation of 250 cc of mineral oil by rectal tube and permitting it to remain for two hours A saline enema is then given, and its results evaluated by a second rectal examination At this time it may be essential to break up the impaction with the finger, but prior to this morphine should have been given, for it is quite painful, rarely is a general anesthetic required If necessary, the series is repeated If this is not immediately curative mineral oil is given by mouth perhaps with a dose of magnesium sulfate, and the entire procedure repeated the following day However, one series of enemas, with some digital assistance, usually suffices to remove the impaction Recurrence is rare once the patient is freely ambulatory

ELECTROLYTE IMBALANCE

The four states of electrolyte imbalance met often postoperatively (exclusive of oliguria) are (1) water excess, (2) water deficit, (3) deficits of sodium chloride or of potassium and (4) *mixed deficits*

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struction (losses into the bowel in high jejunal obstruction would soon be apparent because of vomiting)

Fluid replacement is determined by the clinical and laboratory evaluation of need (p 13)

ALLERGIC REACTIONS

The surgeon most often encounters allergic reactions following the use of local or topical anesthetics, or the injection of drugs or materials for roentgen visualization, or following the intravenous infusion of various solutions One of the most startling reactions that we have observed in recent years occurred during the administration of protein hydrolysate solution The patient first noted marked and extremely rapid swelling of the lips, then generalized hives, then extreme difficulty in breathing and, lastly, severe swelling of the tongue All of these phenomena appeared within a few minutes and, between heaves, the patient, a 19 year old male, gasped that if his tongue were to swell much more he could no longer breathe—a very pertinent comment under the circumstances, it seemed to us

First, the protein hydrolysate infusion was removed Second, 0 5 cc of 1/1000 epinephrine was injected intramuscularly and the site massaged This soon afforded some symptomatic relief but generalized "asthmatic" rales or squeaks continued with severe dyspnea Third, intravenous aminophylline was given slowly

Within 5 minutes from the beginning of the epinephrine followed by aminophylline the patient's respirations had become much less labored, and the pulmonary rales were decreasing in prominence The swelling of the tongue and lips began to regress The urticaria persisted somewhat longer, but it too gradually faded

This patient was in the most extreme distress at the height of the attack, and the tidal air exchange was exceedingly small No one on seeing him then, could doubt that such sensitivity phenomena might prove fatal in some subjects

Intravenous hydrocortisone might have been equally effective, but the epinephrine was instantly available in the floor medicine cabinet Convulsions would have been managed with intravenous thiopental, and with artificial ventilation

HICCUPS (HICCOUGHS SINGULTUS)

Hiccups are due to diaphragmatic spasm against a closed glottis The occasional or isolated hiccup is of no significance, but the con-

Water excess results from the infusion of too much glucose or other solution at a time when postoperative hormonal changes reduce renal water excretion (by increasing renal tubular reabsorption) The patient exhibits a gain in weight or markedly positive water balance *on the intake-output record, and edema may be manifest* The plasma sodium and chloride levels will usually be subnormal *Water intoxication* may produce convulsions which are effectively treated by the infusion of from 500 to 1000 cc of 3 per cent sodium chloride solution

Water deficit may indeed occur, so thoroughly have physicians been warned against postoperative overhydration This results at times from failure to take into account the patient's profuse sweating, when writing for the fluid intake It is to be recalled that the intake must approximate the losses by urine, gastric suction and stool *plus* estimated insensible loss (which may range from 1 to 6 liters in an extensively burned subject) The urine output will be reduced in the patient who has a water deficit, and the plasma sodium and chloride levels will be elevated if proportionate losses of these electrolytes have not occurred The intriguing *hypernatremic hyperchloremia* reflects pure water deficit in some patients

Sodium, chloride, and *potassium deficits* are readily produced by limiting intravenous fluid replacement largely to salt-free solutions, when nasogastric suction is removing significant amounts of gastric fluid containing these electrolytes Metabolic alkalosis usually results Of course, even without gastric suction one can eventually deplete the patient of electrolytes (by renal excretion) if only salt-free solutions are infused Electrolyte deficits are uncommon when patients are consuming a normal diet, except perhaps when adrenal steroid therapy produces a marked excretion of potassium with a resulting *deficit of this ion, in such circumstances metabolic alka*losis may develop

Appropriate replacement therapy is indicated (p 13)

Mixed Deficits As might be expected most of the etiologic circumstances under which water and electrolytes are lost result in a mixed or balanced deficit in which the extracellular fluid remaining to the patient is reduced in volume but has a relatively normal electrolyte content This is particularly true following such *third space* losses as wound edema massive ascites of pancreatitis or other disease, pleural effusion retroperitoneal edema following pelvic fracture, or concealed losses into the small bowel in low ob

struction (losses into the bowel in high jejunal obstruction would soon be apparent because of vomiting)

Fluid replacement is determined by the clinical and laboratory evaluation of need (p 13)

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Hiccups are due to diaphragmatic spasm against a closed glottis The occasional or isolated hiccup is of no significance, but the con-

dition can persist until the patient is exhausted The *etiology* is varied, but quite often gastric retention or intraperitoneal sepsis will be found However, many times no adequate explanation is forthcoming

Treatment consists of one or more of the following measures (1) rebreathing into a paper bag (2) inhalation of an oxygen-carbon dioxide mixture, (3) spraying the posterior pharynx with ethyl chloride, (4) sedation, (5) phrenic nerve block on the involved side (as determined by fluoroscopy), and (6) chlorpromazine Fortunately, whereas the first five of these often prove ineffective in permanently arresting persistent hiccups, *chlorpromazine* has proved gratifyingly effective in this condition

POSTOPERATIVE PSYCHOSIS

Minor mental changes are common following surgery and other illnesses and from time to time a patient will become delirious and even maniacal Excluding patients who were known to have been mentally unbalanced previously, the causes may or may not be apparent Drug psychosis must always be considered, and the poor tolerance of some elderly patients for barbiturates is well known However, there are other subjects in whom the stress of anesthesia-operation *per se* produces mental imbalance

The *treatment* of postoperatively disturbed individuals consists of reassurance, close and constant observation, sedation with a barbiturate, and/or the initiation of one of the tranquilizing drugs such as chlorpromazine (25 to 50 mg P O q i d)

Even so, at times a male patient may threaten violence to anyone who approaches him Under these circumstances there are two alternatives either he must be allowed finally to go to sleep, or several husky persons must rush him, subdue him and thereafter restrain him with or without injected sedative Circumstances will dictate which of these alternatives is to be elected

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24 *Evening Rounds: An Intern-Resident Check-List*

A SMOOTHLY FUNCTIONING surgical service does not come about by chance Behind the scenes there is intelligent, intensive and continuous activity on the part of an alert housestaff And few service functions are more essential to effective patient care than are the thoughtful and meticulous rounds conducted by the intern or resident himself in the late afternoon or early evening

The purpose here is to review the objectives of evening rounds, and to offer a few check lists of points to be considered before and after certain representative operations

GENERAL APPROACH

The resident will plan to achieve the following objectives

(1) *New Admissions and Those Under Study*
  (a) Initial evaluation
  (b) Plan and begin arrangements for indicated studies or therapy Proceed with a specific target date for operation in mind
  (c) Re-evaluate the current progress of preoperative studies and therapy of patients admitted previously
(2) *Preoperative Patient* (For Tomorrow)
  (a) History and physical examination evaluated and recorded
  (b) Essential laboratory data recorded on chart (blood work urinalysis chest x ray ECG etc)
  (c) General physical status at the moment (febrile? dehydrated?)
  (d) Preoperative orders written (anesthesia consult indicated?)
  (e) Blood ready for transfusion
  (f) X ray films available
  (g) Patient family (certainly of children) and referring physician informed
  (h) Case posted with operating room nurses
  (i) Special x rays in operating room or frozen section examinations scheduled
  (j) Any other special requirements of the individual case (e g availability of suitable graft hypothermia or pump-oxygenator in cardiovascular cases)
  (k) Operative permit signed and witnessed
(3) *Postoperative Patient* (Consider Requirements According To Which Postoperative Day Is Involved)
  (a) Day of Operation Points of Importance
    1 *Examine patient* briefly (check vital signs and auscult to determine quality of pulmonary ventilation) Is sedation adequate?

2 Intake-output status
3 Nurses notes
4 Clinical (temperature) chart
5 Wound drainage excessive?
6 Chest film? (resident should inspect personally)
7 Bladder distention, intestinal distention, vomiting?
8 Repeat hemoglobin or hematocrit determination if indicated
9 Consider special features of the individual case
10 Order sheet Are the written orders being executed?
11 Studies required tomorrow (plasma chemistries blood count or chest x ray?)

(b) Days Postoperative
1 *Think* concerning particular requirements of the day
a Rewrite orders? Oral intake?
b Ambulate patient?
c Remove chest tubes urinary catheter nasogastric tube T tube (after cholangiogram) drains dressings, cast sutures or other materials?
d Plasma chemistry, urine and blood count rechecks?
e Stop antibiotics morphine anticoagulant., chlorpromazine infectious precautions warm moist dressings etc ?
f Any complications threatening?
g Begin clearing the way for patient discharge

These are a few of the innumerable details which must be thought of and taken care of Yet they truly represent the essence of good preoperative and postoperative care Now will be listed further reminders for several common operations which will individually serve as prototypes of procedures involving the several anatomic and physiologic areas of the body Certain of these points have been mentioned elsewhere in the volume, but it is desirable to list them again here

SOME SPECIFIC OPERATIONS

Thyroidectomy

Preoperative

(1) Rule out toxicity (clinical examination B M R PBI radioiodine uptake)
(2) Examine cords by indirect laryngoscopy
(3) Chest x ray for substernal extension
(4) Crossmatch blood for toxic or large goiter
(5) Write routine preoperative orders
(6) Schedule frozen section if carcinoma suspected

Postoperative

(1) Vital Signs Respiratory difficulty suggests tracheal obstruction (p 90) Rapid pulse and respirations with fever suggest element of toxicity Treat with I V sodium iodide oxygen therapy and sedation and use digitalization and intra

venous hydrocortisone if indicated Also scan nurses notes clinical temperature chart and progress notes for clues and trends

(2) The Wound Is drainage excessive or bloody? Is there a deep fullness of the neck? If any indication of respiratory difficulty (due to tracheal compression) open wound and perform tracheostomy under local anesthesia *Don t use Pentothal*

Normally remove drains at end of 24 hours and sutures at 48 hours

(3) Vocalization Ask patient to speak If hoarse examine cords with laryngeal mirror

(4) Tingling or Tetany These findings suggest hypoparathyroidism Confirm with Chvostek s sign and draw blood for determination of serum calcium and phosphorus levels

(5) Intake output Are fluids in? Urine? Diet as tolerated after day of surgery

(6) Ambulation Has patient been got out of bed?

Thoracotomy

Preoperative

(1) Diagnostic work up complete? (History physical examination plain and special chest x rays bronchoscopy sputum studies lung function tests skin tests?)

(2) Adequate blood for transfusion

(3) Chest x rays available for surgery

(4) Preoperative orders written (p 65)

(5) Postural drainage immediately prior to surgery where indicated

Postoperative

(1) Vital Signs Reacted? Hypotension and tachycardia suggest atelectasis or more often oligemia due to inadequate replacement of losses at surgery or to continuing hemorrhage Fever suggests atelectasis pneumonitis or other complications (p 115) Investigate immediately Also scan nurses notes clinical temperature chart and progress notes for clues and trends

(2) Wound and Tube Drainage The thoracotomy incision rarely separates and wound hemorrhage and serious infection are unusual Half the sutures are removed the sixth P O D and the rest on the eighth

Thoracotomy tube drainage is exceedingly important following pulmonary esophageal mediastinal or cardiac surgery Is the column of fluid in the underwater tube oscillating with each respiration? Is drainage excessive and bloody? Is air leakage (following lobectomy or segmental resection) excessive? If tubes are not functioning they must be opened by instillation of sterile saline solution or replaced Continuing hemorrhage may require reoperation

(3) Cough Out Use nasotracheal catheter suction where required

(4) Chest X ray Valuable as are inspection and auscultation (the dressings impede palpation and percussion) a chest film taken the evening following surgery is invaluable in the early detection of hemorrhage atelectasis and pneumothorax All three must be effectively treated promptly if a well expanded lung is to be achieved The surgical resident should personally examine this film

(5) Intake Output Check blood and other fluid and urine output

(6) Ambulate and give *diet* as tolerated beginning with first P O D Continue

frequent and aggressive measures to prevent atelectasis until lung is well expanded (check with serial films)

Aortic Resection (Abdominal)

Preoperative

(1) Sites or site of occlusion or aneurysm localized by history, physical examination and where indicated aortogram
(2) Assess general condition (p 7)
(3) Crossmatch 3000 cc of blood
(4) Pass alimentary tube and insert Foley catheter
(5) Have homograft or artificial prosthesis available
(6) Schedule operative arteriograms with radiology
(7) Anesthesia consult
(8) Routine orders (p 65)

Postoperative

(1) Vital Signs Reacted? Hypotension and weak thready pulse may be due to oligemia but need not be Get hematocrit and hemoglobin levels Suspect heart failure (coronary occlusion? hypertensive decompensation?) pulmonary embolism mesenteric occlusion bowel necrosis due to ischemia or infection Scan nurses notes and clinical temperature chart for clues and trends
(2) The Wound There is commonly a moderate peritoneal effusion often admixed with lymph from perforated cisterna chyli and wound drainage is not unusual However hernia formation or even evisceration are common following this operation and all wound drainage should be taken seriously Leave skin sutures for 10 days retention sutures from 12 to 14 days
(3) Lower Extremities *Pulses* should be present in the femoral arteries If they were present in the external iliacs at the end of operation but could not be felt in the femoral region they may develop later However disappearance of previously present pulsations especially if associated with questionable viability of the extremity demands a decision concerning re-exploration *Power and sensation* in the legs should be checked
(4) Intake Output Blood and fluid infusion adequate but not excessive? Urine output? Uremia a definite hazard in these patients Use Foley indwelling catheter
(5) Nasogastric suction to prevent distention
(6) Ambulate on individual basis *Diet* as tolerated when tube removed

Biliary Surgery

Preoperative

(1) Establish presence of gallstones
(2) Rule out other diseases
(3) Assess general physical status (p 7)
(4) Differential diagnosis—and therapy—in jaundiced patient where indicated Prothrombin levels and vitamin K administration
(5) Pass Levin tube prior to surgery
(6) Schedule operative cholangiography

venous hydrocortisone if indicated Also scan nurses' notes clinical temperature chart and progress notes for clues and trends

(2) The Wound Is drainage excessive or bloody? Is there a deep fullness of the neck? If any indication of respiratory difficulty (due to tracheal compression) open wound and perform tracheostomy under local anesthesia *Don t use Pentothal*

Normally remove drains at end of 24 hours and sutures at 48 hours

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(5) Intake Output Check blood and other fluid and urine output

(6) Ambulate and give *diet* as tolerated beginning with first P O D Continue

while gentle but firm manual compression of the wound is maintained Also check nurses notes clinical temperature chart and progress notes for clues and trend

(2) The Wound Since wound drainage is not usually employed unless the procedure was quite difficult or the duodenal closure uncertain factors excessive serous or serosanguineous drainage through the incision often denotes partial or complete separation of the wound (p 58) This hazard is especially to be considered when intestinal distention hiccup excessive coughing vomiting or infection is present

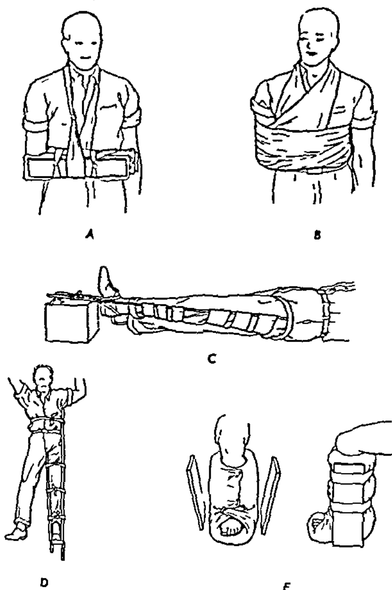


FIG 19—The management of fractures and associated soft tissue injury involves the basic surgical principles of cleaning debridement and immobilization (From Hampton O P Jr., and Fitts W T Jr Fractures and dislocations general considerations *In* Allen J G Harkins H N Moyer C A and Rhoads J E Surgery—Principles and Practice Philadelphia J B Lippincott Co 1957)

(7) Crossmatch to laboratory ("hold)
(8) Routine orders (p 65)

Postoperative

(1) Vital Signs Reacted? Hypotension and rapid thready pulse must be inve ti gated Depressed respirations may reflect exce ive sedation Efficiency of pulmonary ventilation In pection percussion and auscultation of lungs Also check nurses notes and clinical temperature chart for clues and trends
(2) Wound Drainage Excessive bloody drainage may require transfusion Gross blood indicates an unligated vessel and reoperation may be in order Copious bile may reflect severed accessory bile duct injured common duct or slipped ligature on cystic duct Leakage around T tube may be disturbing but usually cea es when T tube is removed Early cholangiogram may be reassuring re garding the last The T tube can be pulled after 7 days for by then a drainage tract has been formed Change dressing if needed Check security of T tube
(3) Nausea Vomiting or Hiccups These findings usually reflect gastric retention after biliary surgery If Levin tube is in place check for patency and effective ness of suction source If no tube was used initially introduce one now aspirate gastric contents and irrigate well with saline solution The tube may then be withdrawn
(4) Intake Output Have the ordered fluids been infused? Has the patient passed urine?
(5) Distention and Gas Pains Peristalsis audible? Passing flatus? Hot water bottle to abdomen Rectal tube to facilitate passage of gas Pitre in or pro tigmin?
(6) Ambulation Within from 24 to 48 hours following surgery depending on pa tient

Gastric Resection

Preoperative

(1) Demonstrate pathology and chronicity with history physical examination and G I series
(2) Routine laboratory work plus pla ma chemistry values
(3) Gastric analy is to determine extent of resection
(4) Decompress a dilated stomach
(5) Fluid and blood replacement where needed
(6) Assess general physical status (p 7)
(7) Crossmatch with 1500 cc blood
(8) Pass Levin tube on morning of operation if not needed previously
(9) Routine orders (p 65)

Postoperative

(1) Vital Signs Reacted? Hypoten ion and rapid thready pulse must be inve ti gated Suspect inadequate blood replacement at surgery or continuing concealed hemorrhage Hematocrit and hemoglobin measurements may be helpful Atelec ta is pulmonary embolus coronary occlu ion or other possibilities must be considered Sudden collapse several days following operation may be due to blow-out of duodenal tump with peritoneal soiling or to severe pancreatitis
Examine pulmonary ventilation with *auscultation* and have patient cough

(3) Levin Tube Drainage Volume? Excessively bloody? Is tube patent? Vomiting around tube? Presence of bile establishes patency of common bile duct and proximal stoma (in Billroth II)
(4) Intake-output Transfusion complete? Required solutions infused? Urine volume adequate?
(5) Abdominal Pain Pancreatitis? Gastric retention? Proximal loop syndrome? Duodenal leakage? Abscess? Dumping? Gas pains? Flatus? Peristalsis?
(6) Routine

Fracture and/or Soft Tissue Trauma with or without Cast (Figs 49 and 50)

(1) Is extremity spontaneously painful after fracture is immobilized? Remove or bivalve cast or dressings and inspect
(2) Are toes cold or numb? Suspect ischemic condition Inspect injury Physical examination and/or arteriogram to detect arterial damage
(3) Motion and power satisfactory under circumstances? Suspect nerve injury or compression in addition to possible ischemia
(4) Patient febrile and toxic ? Inspect wound for infection Antibiotics and further debridement and drainage if not previously adequate Tetanus prophylaxis
(5) Do the repeat films show that satisfactory alignment of the fragments is being maintained?
(6) Does the balanced traction need readjusting?
(7) Routine problems of patient care diet urination bowel movements etc

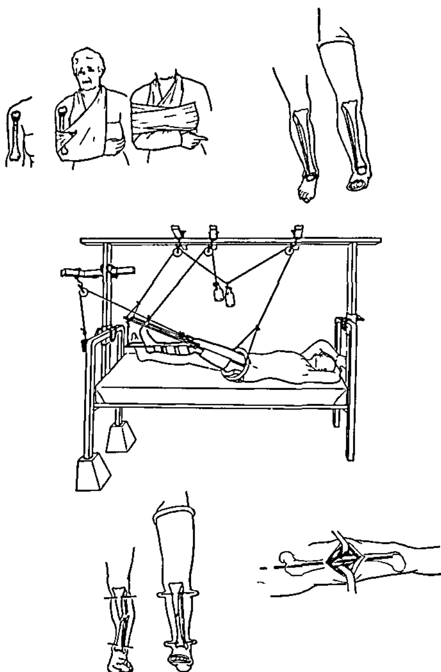


FIG 50—The reduction and stabilization of fractures has come to involve so many different types of appliances and other paraphernalia that the beginner is often dismayed The basic objective is to get the ends of the broken bones together and to hold them there by the simplest and at the same time the most effective means at hand Arterial nerve and other soft tissue damage is sought for and treated if found (From Hampton O P Jr and Fitts W T Jr Fractures and dislocations general considerations *In* Allen J G Harkins H N Moyer C A and Rhoads J E Surgery—Principles and Practice Philadelphia J B Lippincott Company, 1957)

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PATIENT DISCHARGED TO FOLLOW-UP

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